TOPICS OF THE MONTH

Chemical engineering and the fuel problem

A BELIEF that chemical engineering would play a much larger part, in the future, in the processing of coal and turning it into better fuels, was expressed by Dr. J. Bronowski, director of the National Coal Board's Coal Research Establishment at Stoke Orchard, near Cheltenham, recently. He was summing up an international conference on ' Chemical Engineering in the Coal Industry,' which took place at Stoke Orchard and which was attended by delegates from Britain, Germany, the Netherlands, Poland, United States, Canada, South Africa, Japan and many other countries.

Chemical treatment of coal must become more and more an exact science, Dr. Bronowski said, and there is no reason why coal should continue to be a 'poor relation ' among fossil fuels. He expressed the hope that we were entering a time when the coal industry will be the subject of that all-concentrated and exact study which has made the oil industry great. So long as coal continues to have such a low price it is difficult to apply chemical engineering processes profitably, but we are now entering an age when scarcity is becoming as important a consideration as cost.

He said that one result of the Conference had been to reveal the possibility of bringing fluidisation in as a continuous process, thus bringing modern techniques of chemical engineering to the carbonising industry. With regard to the by-product, such as medium-temperature tar, the question that must be asked is not ' Who wants it ?' but ' What can we use it for ?'

The papers presented at the Conference revealed that the conception of a pilot plant varied in different countries. Thus, while at Stoke Orchard they worked usually on a basis of about one ton a day, in France one ton an hour was nearer the mark, while in America again they worked on a much larger scale. Dr. Bronowski pointed out that the different pace of development in different countries may very well be the critical factor in arriving at a solution of the problems posed by the new processes, especially from the economic point of view.

Dr. Bronowski referred to the urgent need for a reformation in the treatment of coal, and said that it may become not only a fossil fuel but also a fossil habit if we do not learn to make better use of it now. He gave an example from the early days of the oil industry, when no other use had been found for oil than to sell it as fuel for kerosene lamps. Those engaged in this trade at the time were quite content to make a profit in this way, not realising the greater possibilities of oil. The coal industry can learn from this.

In Europe the average efficiency in the use of fuel is still less than 25%, Dr. Bronowski declared, and this pointed the moral that the most important single source of energy that is now open is the energy that is wasted. There was talk that atomic energy or oil would render coal unnecessary in the future but we live in an age when we depend on every source of energy. There is no competition between fuels.

A report on the Conference will appear in CHEMICAL & PROCESS ENGINEERING next month.

New expansion plan for Fawley refinery

ENERGY needs have also been given some thought elsewhere in Britain, as is evident by the announcement that Esso Petroleum Co. Ltd. are going to carry out a further £13 million expansion programme at their Fawley (Hampshire) refinery, which will make available large extra quantities of fuel oils. This is the second time that Fawley has been in the news during the past few months, for it was recently announced that this refinery would supply raw materials for the synthetic rubber and chemical plant that is to be set up nearby. The new project is additional to the £9 million plan for this purpose, making £22 million altogether.

When this expansion is completed, at the end of 1958, the total capital investment in the Esso refinery will amount to £68 million, and throughput will have been raised from the current 7½ million to 10½ million tons a year. The programme will include a third pipestill (crude distillation unit) with a capacity of 9,600 tons a day; two new auto-diesel *Hydrofiners*, which will reduce the sulphur content of diesel fuel and improve its quality ; and a second sulphur recovery plant, which will produce 99.9% chemically pure rock sulphur. This plant will double the refinery's current annual output of 14,000 tons of sulphur, which is at present entirely taken up by the textile industry. Other major new items will include a large additional amount of tankage, a new jetty berth, and a new oil and water separator plant.

It is estimated that over 90% of all materials used in the new construction will be British. It is interesting to note, by way of contrast, that during the initial expansion programme (1949-51) the corresponding figure was 66%, due to the relatively long delivery dates for British materials at that time.

These extensions will involve a construction force of well over 4,000 men at the peak period, and will raise the number of regular employees at the refinery from the present figure of 3,100 to approximately 4,000.

Commenting on these plans, Sir Leonard Sinclair, chairman and managing director of Esso Petroleum, said that the company was planning to double its present volume of business within the next five years. Much of the programme is aimed at increasing supplies of the heavier fuels, on which, he said, the British economy is dependent to a steadily increasing extent, and at making these fuels available at the minimum dollar cost. He said that the Fawley refinery

was already saving the country an estimated $150 million a year in foreign exchange, and the new expansion will increase that saving to more than $250 million a year.

Record heavy chemical production in Australia

AN indication of how chemical manufacturing activity is progressing in Australia is given in a survey which takes in the six months up to April, 1956. This reveals that demand for alkalis there continued at the record levels reached during 1955, and that productive capacity for caustic soda, which was increased by additional electrolytic units in 1955, remains adequate for current and prospective requirements. Production of soda ash continues to be supplemented by imports (some 8,000 tons in 1954-55) to meet demand, but Icianz Ltd. plans a further increase in capacity which is expected to come into operation by about the end of 1957. Prices have remained unaltered for alkalis for the last two years, soda ash being £33 17s. 6d. a ton, and caustic soda £70 a ton.

The persistence of record demand for alkalis reflects the high level of manufacturing activity during the last six months, and indeed the survey, compiled by the Industries Division of Australia's Department of Trade, shows that Australian manufacturing industry generally during the period was the highest in its history. For the alkali industry the prospects for the remainder of 1956 are directly dependent on the maintenance of buoyant conditions in industry generally.

In the chemical fertiliser field, production of superphosphate continues to reach record levels. For the 12 months to the end of February 1956 output was 2,174,000 tons, an increase of some 16% over the previous 12 months. Production for the six months ended February 1956 was 1,129,000 tons—an increase of 11% compared with the same period a year previously. Increases occurred in all States, the largest being in New South Wales and Western Australia where in each case production for the 12 months was over 20% higher. Production for the whole year 1955-56 is, however, not expected to show such high increases over those in 1954-55. This is because production peaks have been scheduled to occur earlier in 1955-56 than in the previous year.

Production of ammonium sulphate for the 12 months to the end of March, 1956, was 74,760 tons, or some 4% lower than for the 12 months to March, 1955. The figure for the six months ended March 1956 was 38,300 tons, compared with 38,100 tons for the period to March 1955. Generally, production has been fairly static.

Production of ammonium sulphate is expected to increase significantly from now on with the new plant of Electrolytic Zinc Co. Ltd., at Risdon, Tasmania, in production.

In plastics, the recently announced project of Icianz to make polythene at Botany, New South Wales, at an outlay of £2.25 million, is the outstanding current expansion being undertaken in Australia. Initially production will be based on industrial alcohol, which is comparatively cheap in Australia, but later ethylene from petroleum may be used. It is expected that production will begin in 1958 and that output will initially reach 5,000 tons p.a.

The second most noteworthy project in the industry generally is the new Beetle-Elliott factory at Box Hill, Victoria, which will commence operation in May 1956 and will specialise mainly in ' still ' products.

Polythene's new rival

THE new plastic, polypropylene, which has been developed by Dr. Giulio Natto, of the Milan Polytechnic Institute, and his associates, in a project supported by the big Italian chemical concern, Montecatini, had its introduction to the United States recently, when several U.S. firms were quick to start negotiations for the licence to manufacture it. Meanwhile, Montecatini, who have been operating the process on a pilot scale up to now, are going ahead with the construction of a full-scale plant near Ferrara, Italy, which is scheduled to produce several tons of polypropylene a day by the end of 1956.

Polypropylene is claimed to have greater heat resistance and a higher tensile strength than polythene, and also to have greater resistance to organic solvents. It is expected to have wide commercial applications in moulded and extruded goods, and also as a synthetic textile fibre.

South African mining ventures bring prosperity to farmers

A RECENT United Nations review of economic activity in Africa for 1954-55 states that, in the Union of South Africa, while the relative importance of mining rose for the first time in four years, as output expanded by 11% in value (owing mostly to the opening of new mines producing gold and atomic materials in the Orange Free State), agricultural output declined substantially in value.

There may well be more of a connection between these two circumstances than meets the eye at first, for a correspondent in South Africa reports that some farmers are doing quite well as a result of the prosperity brought to many country areas by mining for base minerals, especially in the northern provinces. Manganese outcrops are being opened in the Zeerust district of the Transvaal, asbestos in the Bustenburg area and beryllium north of the Orange River.

Cash for options, royalties and produce sold to the workmen is flowing into farmer's pockets. Some farmers and country storekeepers have considerable interests in mining propositions on their own lands. One man in the Zeerust district has made a fortune from fluorspar. Some farmers say that they are now reaping bigger profits from chrome than from crops.

Lime is being exploited on farms in many areas, including the Cape. Base minerals, like scheelite in the north-western Cape, andalusite in the Western Transvaal, titanium and columbite are bringing incomes and capital returns to other farmers.

Utilisation of bark-stained timber for paper making

AN article in this issue refers to the prominence of Sweden in the manufacture of cellulose and paper products, and certainly it is to that country that we look for the latest developments in this field. It is as well to bear in mind that the success of the Swedes rests not only on their superior resources of timber, but also on the painstaking research that is directed at improving the efficiency of their manufacturing methods to meet changing circumstances.

An example of their persistence is the development, following a decade's research into the problem, of a process whereby timber with heavy bark stains can be fully utilised for paper making. Evolved by the Swedish Cellulose Co. and successfully tried out at two of the mills belonging to the company, this patented method, it is claimed, can be used even for cooking pulp for high-grade white paper such as grease-proof paper. Involving a two-stage cooking, the new process removes the ill-effects of the phenols that cause the darkening, and which, normally, after a certain storage period, appear as spots in the final product.

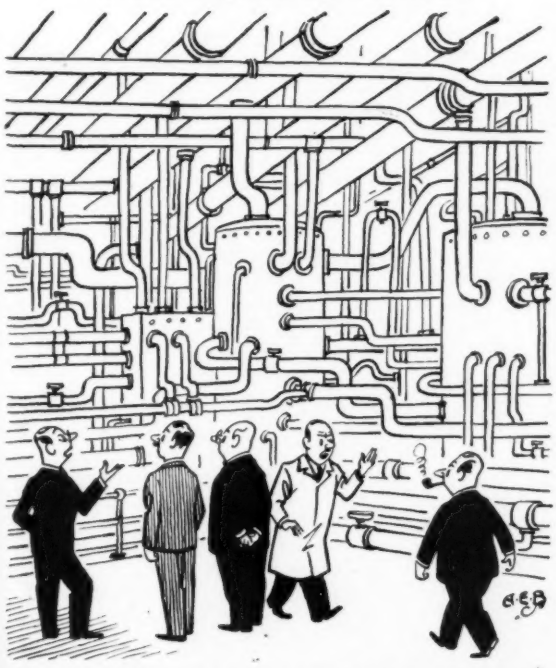
Some ten years ago, before the development of transportable barking machines, when the shortage of forestry workers was beginning to make itself felt, it was found necessary to float spruce timber in an unbarked condition, and up to 15% of a spruce log would be of inferior quality because of the bark stains produced during transport. Many methods were tried to eliminate the cause of the bark stains, but they were found too expensive, even where the entire log could be saved.

The new method, however, besides being cheap, has the advantage of making possible the production of about 10% more high-class pulp from injured wood. It is also said to yield a commodity which is easier than ordinary pulp to screen and dry.

The first cooking takes place in a solution containing 3% of natrium sulphite which is extracted after 2 to 3 hr. A calcium bisulphate cooking acid is then pumped in and the cooking continues for about 4 hr., depending on the desired quality of the finished product. The solution drawn off from the first cooking—about 75% of the original liquid quantity—can be used again without reprocessing.

Chief among the main items of expenditure in connection with the new process are the more expensive chemicals; a moderate investment in new buildings and cisterns (Kr. 700,000 or about £50,000 at the mills concerned); a somewhat larger requirement of steam; and the use of one more worker per shift. These, however, are more than compensated for by the increased pulp production and the saving in natural resources.

Comical Engineering Situations



"SORRY, SIR—WE DON'T ALLOW PIPES IN HERE"

Ice heats air in Canadian mine

A UNIQUE air conditioning system that raises the temperature of cold air in the winter by making ice and uses the ice to reduce the temperature in the summer has been put into service at the Stobie section of the International Nickel Co's Frood-Stobie Mine in the Sudbury District of Ontario, Canada.

Instead of stoking the furnace or turning on the oil burner when the thermometer dives below zero during northern Ontario's frigid winters, ice production is stepped up to take the chill off the fresh air supplied from the surface to the mine workings. The basis of this unusual system is a convenient twist of nature whereby heat is released when ice is formed.

The fan that delivers the air to underground has a diameter of 198 in., and is one of the largest in the world. This powerful fan, which has a top capacity of 750,000 cu. ft./min., blows fresh air from the surface through a 300-ft. vertical airway 20 ft. in diameter into two huge open stopes mined by the blasthole method for this purpose between the 300 and 500-foot elevations. Each stope is 80 ft. wide, 200 ft. long and 200 ft. high, and the stopes are separated by a pillar 70 ft. wide. The air circulates through the two stopes in succession on its way to the main intake.

Water from the mine's main pumping system is furnished at 120 pounds pressure to the four spray points at the top of each stope. The volume of water required in winter months varies up to 200 gal./min. The fine particles of water sprayed into the air passing through the stopes turn to ice, and the heat given up in the process is transferred to the air. Some 40,000 tons of ice were formed at the bottom of the stopes during the past winter. This heat, along with that absorbed by the air from the large area of wall

rock exposed in the stopes, added up to 15,000 million B.Th.U., or the equivalent of burning 100,000 gal. of oil or 850 tons of coal.

Although the surface temperature during the winter ranged to 25° below zero, the fresh air delivered from the main intake of the mine ventilation system 600 ft. below surface varied only between 27 and 30° above zero as a result of its side trip through the ice stopes. The temperature eventually is expected to be held at about 32° above zero as the system is improved.

When the volume of air handled through the system ultimately reaches full capacity of 750,000 cubic feet per minute, as compared to 150,000 to 300,000 c.f.m. during the past winter, upwards of 140,000 tons of ice will be formed in the stopes during each winter. In the summer the ice will be melted as the warm fresh air passes through the stopes, and the air will be cooled between 5 and 10°.

Pipelines to hell

THE world seems to be positively humming with news about oil pipelines at the moment, with discussions about the income tax payments on the Iraq Petroleum Co.'s pipeline through the Lebanon; the setback to the trans-Canadian pipeline schedule caused by the strike in the U.S. steel industry; and now a report that Europe is to have a pipeline that will stretch from Marseilles to Rotterdam. The Royal Dutch-Shell Group is named as the principal company concerned in this last project which, however, does not seem to have taken any definite shape at present.

At any rate, the general picture for the future seems to be that of oil being pumped up continuously from the bowels of the earth and piped to the far corners of the world through a network of trunklines and control stations. The philosophical might well reflect that there may be something, after all, in the prediction of the old negro minister who was asked to explain what was meant by 'Hell'. He decided to include this explanation, for the benefit of all, in his Sunday sermon, which went roughly as follows:

'Brethren, Ah'm a-gonna explain to you jest what it means, this word Hell, which is like dis heah. When Gawd made de ole world, he made it good and round. An' he done made the world so's it could spin and get de good sunlight fust on one side, den on de udder. An' so's de ole world could spin good an' proper, he done put an axle right through the middle, stretchin' from de North Pole to de South Pole.

'Now, brethren, everybody knows dat when you got an axle, dat axle gotta hev loo-brication. So Gawd put some oil down in de middle of de Earth, all along round dat ole axle.

'Well, by an' by, de oil men came wid their drills, and done drilled holes right down through de Earth, and started fer to take up de oil. Brethren, dey was very greedy men and dey keeps takin' more and more of de oil dat de good Lord put dere for to grease dat axle.

'Pretty soon, brethren, when de men keeps takin' de oil away, dat axle is a-gonna get hot. An' dat'll be Hell, brethren—dat'll be Hell.'

Solvent evaporation in the laboratory

SIDE by side with the increasing use of instruments and automatic controls in manufacturing plants goes a steady progress in the invention or improvisation of devices to carry out tedious and time-consuming operations such as shaking, stirring, etc., in the laboratory. This is a good thing, for trained men are too valuable these days to spend their time performing monotonous mechanical tasks.

One device that has recently come to light is a mechanical swirling device for vacuum evaporation, and which is the subject of a patent application. Normally, in this operation, it is usual for the operator to swirl the evacuated flask of solution, by hand, in or over a steam bath so that local over-heating cannot take place and frothing is partly suppressed by centrifugal action. If the solution holds solvent tenaciously—as in the case of many oils—it may be necessary to swirl the flask manually all day to remove the last traces of solvent, even when very low pressure is employed.

This clearly unattractive state of affairs was discussed in a recent issue of *Vacuum* in which P. R. Watt, of the Walton Oaks Experimental Station of Vitamins Ltd., points out that the commercially available flask shakers, whilst producing very good turbulence in the contents of the flask, are not very suitable for solvent evaporation since they are likely to induce frothing under vacuum conditions. Hand swirling, on the other hand, produces a vortex in the flask contents which has a large surface area and, by its centrifugal action, tends to suppress foaming. This is the normal laboratory method and occupies one operator per flask during the period of evaporation.

A simple mechanism has been arranged which moves the flask in a manner similar to that produced by wrist action and so dispenses with any internal rotating parts. By driving from above the level of the flask, the bottom of the flask can be left clear, so that it may be held in or over the source of heat whilst evaporation is taking place. The action is identical with that produced by hand swirling, but, being mechanical, it is more regular and can be adapted to greater rates of evaporation by increasing the speed of swirling. Moreover, one drive may be used to swirl a number of flasks at once, so that one operator can attend to four or six flasks at a time.

Once made, the unit can also be used for agitating titration flasks, for hydrogenations and for similar laboratory duties. For small flasks up to 250 ml., the motion may be transmitted directly through a standard cone connection fitting into the neck of the flask and, where this method is applied, any number of flasks can be swirled and pumped from common pumping and driving systems.

A modification of this device can be used to provide a flexible wide-bore link between a swirling distillation flask and a static glass fractionating and condensing assembly. This takes the place of the conventional air or nitrogen leak in vacuum distillations, where recovery of both distillate and residue is important.

PNEUMATIC TOOLS in Maintenance Work

By A. E. Williams, PH.D., F.C.S.

Pneumatic tools have proved themselves a valuable aid to the maintenance of many items of chemical plant such as evaporators, pumps, heat exchangers, etc., as well as steam-raising plant, machinery and buildings. Here the various types of pneumatic tools and their uses are summarised and the maintenance of the tools themselves is also discussed.

MUCH of the drudgery that has hitherto been associated with maintaining machinery, plant, buildings, etc., in good repair has been eliminated in recent years by the evolution of a range of tools operated by compressed air, which are designed to do a specific job more thoroughly and at higher speed than can be done by manual labour. The descaling of boilers and other units of steam-raising plant can now be performed in a small fraction of the time previously taken up by this operation. The grinding of pump chambers, cylinder walls of compressors, and other items of plant where a perfect fit is required between cylinder wall and piston, is carried out with great facility by the use of the appropriate pneumatic tool.

Removing rust from steelwork, girders, etc., prior to painting, was at one time a slow and laborious job, but the rust is now removed with a pneumatic hammer at a speed comparable with the painting of a similar surface. Cutting a channel in concrete or stonework prior to the insertion of pipes, electrical conduit, etc., has also become the normal task of the pneumatic hammer.

These are merely typical examples of the way in which pneumatic tools can save money by doing a particular task in a short time and so enable the machine or plant to get back into operation without loss of output.

Descaling

The descaling of (removing hard scale from) boiler tubes, evaporators, etc., has to be carried out periodically (Figs. 1 and 2) in order to maintain the efficiency of the plant. The tubes themselves are always very good conductors of heat, but if scale is allowed to form on the tube surfaces, the rate of heat transfer is very much reduced because the scale itself is a poor conductor of heat. It follows that if a boiler, for example, is not descaled periodically the amount of fuel required to raise a given amount of steam can easily be raised by 50%.

Descaling is also carried out to comply with safety regulations, for an unscaled boiler would gradually become blocked up and a serious explosion would be the result. Therefore, the operation of descaling is a routine task which always has to be undertaken with boilers, evaporators, heat exchangers and other heat-transfer surfaces.

The special scaling cutters which have been devised for this work generally operate at the end of a flexible drive to allow the cutter to be inserted into the tubes. Equipment of this type may be provided with multiple spindle gear boxes to allow the use of two or more flexible drives from the same power unit. These multi-spindle geared sets are particularly useful where a large number of tubes of similar size have to be scaled in the shortest possible time. The cutting surface, that is the material that actually contacts the hard scale, is made of case-hardened steel and, as the teeth of the rotating cutter are widely spaced, there is rarely any difficulty with the teeth becoming clogged. In some cases clogging is prevented by the use of a stream of water to continuously remove the scale as it is released by the cutter; in this way a clean cutting surface is maintained.

Fig. 1. An air motor-driven descaling set operating inside the drum of a Stirling boiler.

The inner driving core of the flexible drive which transmits the power to the cutter is made of wire of exceptionally high mechanical strength. In addition to the steel cutting heads, which are available in various sizes to suit the diameter of the tubes to be cleaned, a series of brushes may be employed in place of the steel head for dealing with material of a relatively soft nature and for cleaning out loose scale, etc. Even tubes of such small diameter as $\frac{5}{8}$ in. internally can be treated. However, in the case of these very small tubes, owing to the limited space available, the maximum scale thickness which can be removed is in the region of $\frac{1}{16}$ in. As tube diameter sizes increase, so greater scale thickness can be dealt with.

The efficiency of pumps and compressors can be maintained by periodically grinding away any deposits which have formed on the cylinder walls. For this maintenance work the outfit used is similar to that for descaling, but an abrasive disc is fitted to the working head in place of the scaling cutter. In Fig. 3 the operator is grinding ridges from pump chambers by means of a disc attached to the flexible drive. This tool is also used for eliminating metallic irregularities from pump and compressor chambers, and for the smoothing down of bearing surfaces.

Pneumatic hammers

Pneumatic hammers are available in two basic types. One of these is the so-called drill hammer which, when

fitted to a portable power drill, converts the normal rotary motion to a percussive action, each revolution producing one blow. The other type is one in which the air pressure operates on a piston within a cylinder, so producing a reciprocating or percussive motion.

In most cases the drill hammer is employed for relatively small holes and the percussion cylinder type for larger work. The drill hammer is capable of producing holes in the hardest concrete or masonry, and any type of pneumatic drill which has a speed between 1,500 and 2,000 r.p.m. and a minimum ¼-in. chuck may be employed. Generally speaking, however, the small portable drill is too small to take the hammer mechanism, for its construction is too light to absorb the reaction of the blows produced.

The hammer mechanism fitted to a portable drill includes an automatic clutch to ensure that the striking mechanism does not come into operation until the tool is pressed against the work; this mechanism ceases to operate immediately the pressure is released. Tests with this type of hammer show that in hard well-seasoned concrete it will produce a ¼-in.-diameter hole, 2 in. deep, in 1½ minutes, when used in a drill running at 2,000 r.p.m. According to the density of the work to be hammered, the strength of the hammer blows may be adjusted through light, medium and heavy, as required.

For most purposes where a very accurate hole is required in concrete or masonry, better results are obtained by the use of a pneumatic portable drill in place of the hammer mechanism; this arises because the rotary motion of the drill, as opposed to the reciprocating action of the hammer, produces a hole with smoother walls and less irregularities. Where, however, the hole is merely wanted for plugging purposes for the insertion of a bolt or screw, the hammer is as good as the drill, and tends to be quicker in making the hole.

The cylinder-type hammer is a versatile tool and the working head may be in various shapes to enable such jobs as routing, scraping, chiselling and planishing as well as simple hammering to be carried out, the working heads being readily interchangeable. In this type of hammer, when the trigger is depressed, air pressure on the end of the piston forces it along the hammer cylinder and when nearly at the end of its limit of travel it strikes the end of the tool bit fitted into the hammer. At this stage the movement of the piston uncovers a port in the cylinder wall, which leads a to a further port at a point opposite to a groove machined round the piston. This neutralises the effect of the air pressure used to move the piston into contact with the working head, and together with the natural rebound of the piston from the tool bit causes it to travel back again, thus closing the port, and the cycle of motion is then repeated.

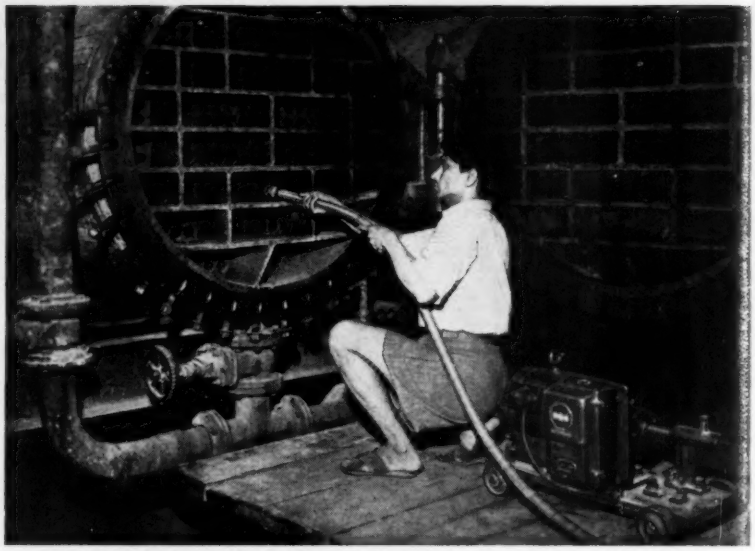


Fig. 2. Part of a plant in India; descaling the tubes of an evaporator.

The simplicity of this valveless type of piston and cylinder design ensures that the tool very rarely breaks down, and only a minimum of maintenance is required. The use of this tool is seen in Figs. 4 and 5, showing respectively the removal of rust and old paint from a steel girder before repainting, and cutting a channel in a concrete floor.

There is a wide range of cylinder-type hammers available to serve innumerable purposes, and the weights of the tools vary from a few pounds to as much as 80 lb. The speed of reciprocation may vary between about 200 and about 7,000 blows/min., while the intensity of the blows delivered is equal to a weight varying between 1 and 80 lb. falling a distance of 1 ft.

Valve controls

While most of the normal sizes of pneumatic hammer operate without a valve, there are on the market somewhat bigger types, used for the breaking up of roadways, releasing minerals from strata, etc., and these are generally valve-controlled, the valve being independent of the reciprocating piston and not mechanically connected as in more general engineering practice. The piston movement in this class of machine is effected by fluctuating air pressures alternating on the two ends of the piston. The fit of the piston in its cylinder is required to be as airtight as possible, compatible with free movement. The same remarks apply to the valve in those machines which are so controlled. Consideration has also to be given to the necessary film of lubricating oil which will also have some sealing effect. When in use, the machines are often operated at

Figs. 1, 2 and 3 reproduced by courtesy of Flexible Drives (Gilmans) Ltd.

Fig. 3. Grinding irregularities from pump chambers by the use of an abrasive disc and flexible drive.

many different angles, and the effects of gravity on valve and piston in these positions has to be combated by efficient design and is chiefly dependent upon correct piston clearances. It follows that the type of lubricating oil used inside the machine must have sufficient viscosity or thickness to maintain a film of oil as a seal between piston and the walls of the chamber. At the same time, the oil must not be thick enough to clog up the small ports which are an essential feature of many of these pneumatic machines.

Air pressures

An important consideration in the maintenance of pneumatic tools is the damage which may easily be done by compressed air at too high or too low a pressure, and more particularly by wet or contaminated air. Most pneumatic tools are designed to give maximum efficiency at air pressures between 80 and 100 p.s.i. pressure and, if the pressure falls below about 70 p.s.i., efficiency of the tool may be reduced by as much as 25%. On the other hand, a pressure of 110 p.s.i. or more will result in accelerated wear on the tool, and quite possibly actual failure of the parts subject to overstressing, as a result of this high pressure. Care should be taken, therefore, in laying out the air mains and, where necessary, pressure controllers should be employed to maintain the air pressure at the tool at the desired level.

Effect of moisture

Apart from fluctuating air pressures, which can do much to destroy the efficiency of a pneumatic tool, water is also liable to be present in the compressed air and such moisture is an enemy of the tool. The only course open to the engineer is, therefore, to endeavour to remove as much water as possible before it enters the tool.

Consider the case where the ambient temperature is saturated, that is, the relative humidity is 100% and at 80°F. An average compressor used for pneumatic tool operation has a capacity of 1,000 cu.ft./min. of free air and is compressing this to approximately 100 p.s.i. In this condition the volume of air contains 1.58 lb. of water in the form of vapour which, if completely condensed out, represents a rate of 9½ gal./hr. of water. This air is delivered direct into the air lines and when it reaches the tool has fallen in temperature to that of the surrounding atmosphere. Having been reduced to only one-eighth of its original volume, which was already saturated, the air will now deposit

Fig. 4. Pneumatic hammer removing rust and paint from a steel girder before re-painting.

Figs. 4 and 5 reproduced by courtesy of Hymatic Engineering Co., Ltd.

Fig. 5. Cutting a channel in concrete with a pneumatic hammer.

1.38 lb./min. of water as condensate. This represents water passing through the tool at the rate of over 8 gal./hr. The effect of this water in the tool is to wash away the desired lubricant and also to create corrosion inside the tool. From this it is clear that it is never a practical proposition to supply air direct to the tools from the compressor, and there are available several different devices for insertion in the line between compressor and tool, with the object of eliminating the bulk of the water in the compressed air.

For example, if an aftercooler is inserted immediately after the compressor, it is possible to extract over 1 lb./min. of this water, or 6.87 gal./hr., and deliver the air to the tools at a temperature of around 100°F. Even if the tools are operating at some distance from the compressor and the air temperature has fallen to 80°F. at the usage point, only about 0.84 gal./hr. of water passes through the tools instead of the full 8 gal./hr.

The removal of the last traces of water from the compressed air is quite feasible, but it involves the use of fairly elaborate plant and the accompanying cost with maintenance. In practice it is found that small quantities of moisture, such as about 8 pints/hr., do not appreciably affect the operation of the tools.

Where small machines which have not built-in lubricators are in use, an efficient type of line oiler should be employed. There are many such devices available and it is good practice to use these in conjunction with some form of oil filter or dirt separator. The larger machines usually have built-in oil reservoirs and the latter is often provided with an adjustable needle valve or a porous element such as felt, to control the quantity of oil passing into the machine. The quantity should be such that the exhaust air from the machine carries a very fine mist, which can be detected on the back of the hand if held near the exhaust outlet.

Rotary movements

Some of the pneumatic tools employed on maintenance work are of the rotary type as distinct from the reciprocating class; an example is the descaling equipment, and the abrasive discs used on pump chambers. These are commonly powered by a sliding-vane type of rotary air motor, although there are still a few piston-type motors manufactured. The rotary motion of these motors is sometimes converted to reciprocating motion in such machines as nibblers, saws and files, and also into impact energy, as in the very useful impact wrench, while their power/weight ratio is in the order of 2 lb./b.h.p.

This shows that there is an amazing amount of power obtainable from a tool which may weigh only a few pounds. The speeds of these rotary pneumatic tools are relatively high, and may be as much as 16,000 r.p.m. on the smaller tools, but on the bigger units the speed is generally between 3,000 and 8,000 r.p.m. High starting torque is a characteristic of the air motor, and it is normally well in excess of the running torque figure.

While such motors are very simple in design, their efficiency in operation largely depends on the ability of the user to prevent air leakage. To keep this to the lowest possible figure, it is necessary to maintain only very small

working clearances within the tool and employ the correct type of oil in the correct quantity. Since all pneumatic tools may be regarded as precision tools, it is important that maintenance should be intelligently carried out.

Tool maintenance

In rotary tools, ball bearings are employed for most bearing parts and, where reduction gears are used, a ball-bearing grease generally proves satisfactory for both. Whenever possible, all machines should be returned to the maintenance store at the end of each shift, where they can be thoroughly examined, tested, cleaned and lubricated ready for the next shift.

Where it is necessary to store a pneumatic tool for any appreciable length of time, an oil containing a corrosion inhibitor should be used. One of the most successful corrosion inhibitors is sodium benzoate, obtainable at most chemical stores; a mixture of 5 parts sodium benzoate to 95 parts oil is satisfactory. The outside of the tools can also be protected with the same chemical. For this purpose the wrapping paper or cloth is impregnated with 25 parts of sodium benzoate to 75 parts water, allowed to dry, then the tool is wrapped up.

Where maintenance of this order is possible, there should be some method of testing each machine to ensure that when handed out to the operator it is up to its rated performance.

For hammers, except for the small valveless types, the pellet test is probably the most simple and efficient device. A mild-steel pellet of precise dimensions and of uniform material and hardness is subjected to the action of the hammer for a period, usually 10-sec. duration. The rate of reduction of length of this pellet, related to the performance of a new machine for purposes of comparison will establish the condition of the tool, coupled with observation of the air consumption.

In testing rotary tools, it is often possible to carry out a practical test such as grinding, etc., or some simple form of dynamometer or air brake can be employed. Again, this test should be compared with that of a new machine and the respective air consumptions noted. This type of procedure will save considerable time and effort, particularly in instances where the tools are to be used at some great distance from the stores. Without previous testing it is quite possible for an operator to take away a defective tool, and so much time is lost.

Tanks, Pits and Vats —Make Them Safe

By H. Allen

MANHOLES, tanks, pits and trenches ought to be absolutely safe places, but statistics show that many accidents occur in such settings every year. Entering and working in enclosed areas are, in point of fact, procedures to which safety codes must be applied.

It is a matter, as always in industrial accident prevention, of locating the hazards. With enclosed areas, the dangers are lack of oxygen or the presence of an asphyxiant gas such as carbon monoxide, an explosive gas such as methane, or a toxic gas such as hydrogen sulphide. All of these are naturally occurring gases that may be generated—particularly in deep manholes—by decaying organic substances.

Material which is not removed from storage tanks even after draining and ventilation is often the cause of explosive or noxious gases released either by vaporisation or through the reaction of the materials to water, cleaning substances, or oxygen. Some solvents and cleansing agents have the effect both of depleting the oxygen supply and of generating toxic gases in enclosed spaces. Such solvents ought never to be used in any pit or tank without proper respiratory equipment.

Trenches

Hazards with trenches mainly centre round the caving-in potential. There have been many such accidents, but only one which occurred recently need be cited for example. A trench to carry sewage was being dug by a mechanical excavator. It was 9½-ft. deep and 2½-ft. wide. As the excavator made a cut, the sides were timbered up to prevent caving. The excavator encountered an obstacle and an operative who was following up the excavator moved forward and began shovelling earth into its bucket. He was working 5 ft. ahead of where the sides of the trench had so far been shored up. A sudden collapse of earth buried him and he died of asphyxia. A second employee jumping in to rescue him was also buried, but rescued alive. Post-accident investigation showed that the collapse occurred on the side of the trench on which the spoil had been deposited by the excavator and that the overburden at that point was excessive. The accident emphasised the danger of working ahead of timbering. Particularly it emphasised the need to frame and honour a safe code of working, with all that that implies regarding employee training and education.

Manholes

In many cases there is a firm blanket of statutory regulation. The design of certain manholes must comply with the requirements of Section 27 of the Factories Act, which states that, where work has to be done inside any chamber, tank, vat, pit, pipe, flue or similar confined space in which dangerous fumes are liable to be present, a manhole must be provided unless there is other adequate means of egress. The manhole may be oval, circular or rectangular and, in the case of tank wagons and other mobile plant, it must measure not less than 16 in. long and 14 in. wide or, if circular, not less than 16 in. in diameter. All other manholes must be not less than 18 in. long and 16 in. wide or, if circular, not less than 18 in. in diameter.

The dimensions of a manhole should, however, be increased from the minima whenever possible in order to make available a sufficient free space for the passage of an operator, ladder, apparatus and—in emergency—an injured man. In designing manholes, it is generally agreed that they should be as nearly as possible flush with the body of the vessel. The greatest possible amount of ventilation should be obtained.

In tanks, the ventilation problem is urgent. Safety training should implant the fact that it is always unwise to assume, without check, that an atmosphere in a tank is safe for entry. It must also be stressed that a routine procedure be followed in a check-up on safety before men are sent in to clean tanks. The following effective system is used by one company to clear CO_2 gas from containers before entry is made.

Cleaning CO_2 gas from containers

The manhole is first opened and an electric air blower is connected in such a way that a complete circulation of air is maintained for a protracted time before entry is made. Tests are taken by candle and then an operative equipped with breathing apparatus

(*Concluded on page* 270)

A SURVEY OF SWEDISH INDUSTRY

Part 2—Chemical Industry

By D. J. Tow and W. C. Paterson

Continuing the article begun in our July issue, in which they considered Sweden's natural resources, fuel and power assets, and metallurgical industries, the authors now go on to show how, despite her lack of domestic supplies of salt, petroleum, coal and other basic raw materials, Sweden has built up a chemical industry of considerable size and versatility.

Forest products

SWEDEN holds a prominent position in the manufacture of chemical pulp, and both the leading processes used in its production—the sulphite and sulphate processes (the product of the latter being best known as 'kraft pulp')—have been perfected and were first introduced there.

Noorland, Dalarna and Värmland contain only 25% of the population of Sweden, but over 70% of the total area and close to 75% of the wooded area. Timber in these regions can be floated down from the forests by way of numerous rivers and streams. Without these advantages the forest products industry would never have been able to achieve its dominant position among the nation's exporters. In 1954 the industry accounted for more than 40% of all exports; in 1951 not less than 55%.

Sawmills and pulp mills are generally situated on river estuaries, but large numbers of logs are floated to points further along the coast.

Utilisation of the forests in northern Sweden first began a hundred years ago, at the time when Britain removed the duties on sawn wood. A very large number of sawmills were constructed, and huge virgin forests were felled. The climax was reached just after 1900 when timber exports exceeded 1 million standards yearly. Today some 700,000 standards of timber are exported, a similar amount being consumed domestically. Only a small part of domestic needs is filled by the sawmills in the north.

Most of the pulp mills still in operation date back to the end of the last century. Productive capacity has risen sharply since then and the mills, especially those producing sulphite pulp, have now reached their capacity limit. The supply of spruce is expected to diminish in favour of pine, the second most important coniferous tree in Sweden.

Chemical pulp mills and sawmills are the two most important consumers of wood. Together they take more than 90% of the raw materials used by the forest industries, while the remainder goes to the mechanical pulp and wallboard industries.

Including wood consumed as fuel (and charcoal) the present forest cuttings correspond approximately to the annual growth. A great deal of labour and expense is being devoted to conservation and reforestation. Careful cutting and thinning, draining of marshes and bogs, seeding and replanting have taken place on a wide scale. Experimentation in tree varieties is going on constantly, a field in which Sweden has long been a pioneer. Because of climatic conditions, the growth per acre is lower in Sweden than in warmer countries and even in middle Sweden growth is often twice as rapid as in the far northern part of the country. A compensating factor is the high quality of Swedish wood.

Chemical pulp developments

In 1951, 1.7 million tons of chemical pulp were exported, a figure that should be regarded as high, since increasing quantities of chemical pulp are consumed by the domestic paper industry, which in turn ships a large portion of its output abroad. With the decline in volume the pulp industry has gradually shifted over to more highly processed pulp. The trend toward quality manufacture has brought about an increasing demand for chlorine and sodium hydroxide and even for sodium chlorate used in chlorine dioxide bleaching.

In recent years various highly refined grades of sulphite pulp have been evolved, chief among them being viscose pulp for the manufacture of rayon, staple fibre and other synthetic products. The bleaching off of kraft pulp represents another great advance in this field. Considerable attention has been devoted to the recovery and further chemical treatment of the by-products from the manufacture of chemical pulp. The most important

A modern power plant at Traryd, on the river Lagan, in Sweden.

of these by-products, quantitatively speaking, are ethyl alcohol from sulphite, and tall oil obtained in the sulphate process.

Cellulose by-products are methanol, turpentine and, above all, liquid rosin. Each year, 25,000 tons are converted from liquid rosin through vacuum distillation to tall oil, which now completely replaces soya-bean oil in making soft soap, alietic acid and pitch. Spruce bark and oak have long furnished tanning materials and furfural, which are mainly for export.

Stone, cement and glass

The paving and building stone section of the granite industry has suffered a long slump, but production and exports of fancy stone have increased. The cement industry has more than doubled its output since the war and eight large, modern plants account for this increased production. Exports are mostly to overseas countries, amounting to a record 300,000 tons in recent years.

Glass manufacturing is of importance, though handicapped by lack of raw materials and cheap fuels. However, skilled craftsmen and outstanding artists have co-operated to produce a decorative glass which is highly esteemed abroad.

Electrochemical industry

The water-power resources are mainly located in the regions where timber is floated, and more than half of the potential water power is north of the 64th parallel.

Production of hydroelectric energy during the past ten years has doubled and is now about 21 billion kwh. annually, or 2% of world production. Based on present-day technical achievement, potential water power is estimated at 60 to 70 billion kwh. annually.

Sweden was in the foreground of electrochemical industry development when it began in many countries around the 1890s. Five companies are now engaged in the manufacture of chlorine and alkali, and are all owned by the cellulose industry, the largest consumer of these products. Chlorine production amounts to 75,000 tons, or about 2½% of world production. Output of alkalis is proportionate to the volume of chlorine production.

Sweden produces sodium hydroxide from common salt which, like potash salts, must be imported. This has not, however, prevented the expansion of the domestic chlorine-alkali industry, which is located close to the consumers and mostly delivers its products in liquid form.

Drillings to great depths in the southernmost part of the country have revealed considerable salt beds. They have not been developed because only two-thirds of the deposits consist of common salt, and most of the remainder is calcium chloride.

The manufacture of chlorates and perchlorates began at a very early date, and potassium chlorate is sold in large quantities to foreign subsidiaries of the match industry. The production of phosphorus covers only a small part of national requirements. Practically the entire demand for phosphoric acid is met domestically by manufacturing phosphorus electrochemically, and by treating of crude phosphate with sulphuric acid. Sufficient quantities of hydrogen peroxide are also produced.

The manufacture of calcium carbide was started as early as the end of the 19th century. Coke has to be imported, but the other raw materials come from domestic sources.

Other heavy chemicals

The availability of fairly cheap electric power encourages the manufacture of synthetic ammonia, but profit is dependent for the most part on the cost of manufacturing hydrogen. The nitrogen plant at Köping produces hydrogen by passing steam through coke, and ammonia plant at Ljungaverk has manufactured hydrogen electrolytically since 1928. Both plants make nitric acid out of part of the ammonia. Nitric acid and ammonia jointly produce ammonium nitrate which in turn yields fertilisers.

In electric furnaces similar to those used in carbide production, considerable amounts of ferro-alloys are manufactured for the steel industry and foreign markets. Aluminium production, which during the war was based in part on raw material from the Skellefte field but depends in peacetime on imported bauxite, has risen to 12,000 tons.

Sweden annually consumes about 300,000 tons of sulphur, which comes mainly from the mining of pyrites in the Skellefte field, from the Falu mines, and from the production of elementary sulphur in shale distillation. The two great consumers are the sulphuric acid and sulphite cellulose industries. A large quantity is also used in manufacturing carbon disulphide for the rayon industry.

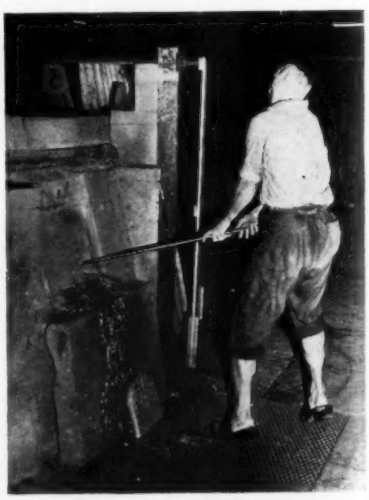
The largest user of sulphuric acid is the superphosphate industry with a productive capacity exceeding 500,000 tons, equal to the large domestic demand for this fertiliser. In addition, sulphuric acid is widely used by such industries as steel, rayon and explosives and, above all, in the manufacture of a number of chemicals such as aluminium sulphate, sodium sulphate, hydrochloric acid, calcium chloride, sodium phosphate and dicalcium phosphate.

Aluminium sulphate has long been an important export product, while the demands for sodium sulphate in the sulphate cellulose industry, and for calcium chloride, which is used for dust binding on gravel roads, greatly exceed domestic production and 90,000 tons of each chemical are imported yearly.

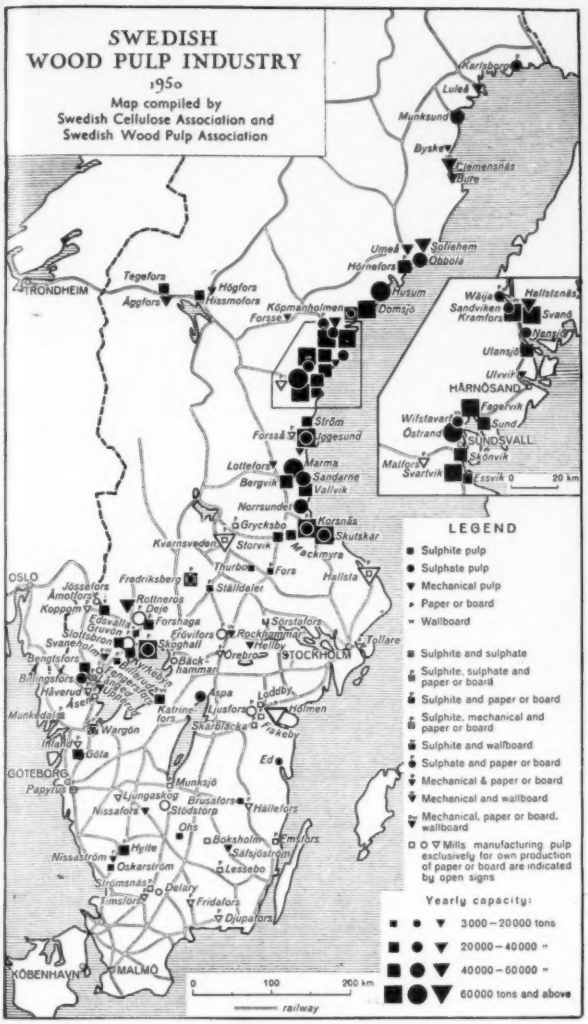
Chemicals from coal and petroleum

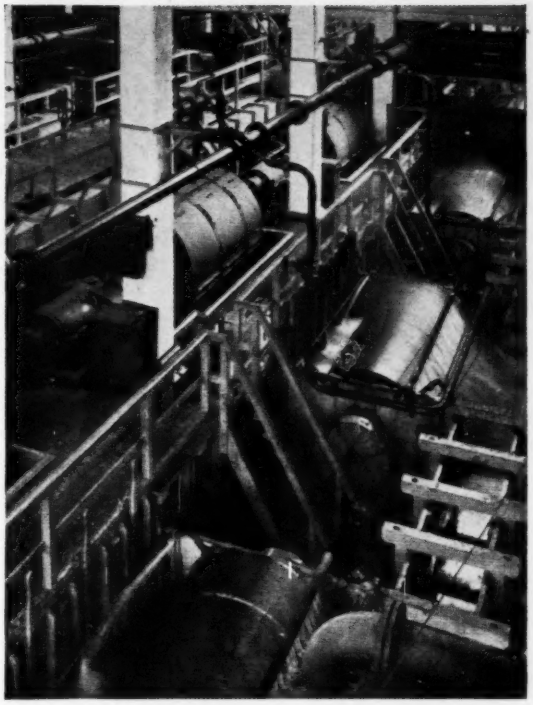
The growth of Sweden's chemical industry has been hampered by lack of basic raw materials like petroleum, coal and common salt. Still there exist varied and comprehensive products based on available domestic materials and imports. Outstanding products, known all over the world and based on Swedish inventions, are safety matches and explosives. During the war, chemists started synthesising locally available substances to give the industry an impetus the effects of which can be seen today. From 1946 to 1950 the rate of expansion was 10% a year.

As examples of Sweden's growing petroleum industry, a refinery in Gothenburg has recently increased its capacity beyond 1 million tons of crude oil, while another in Nynäshamn has an output of half a million tons. In conjunction with this refining activity it is possible to manufacture basic industrial chemicals such as



Glass making at Orrefors.





Above :

View inside a Swedish pulp mill.

Left :

Location of pulp and paper factories.

alcohols, acetone, benzene, toluene and phenol, but domestic consumption of most of these petrochemicals is too small to be profitable. Sweden has no basic chemical industry for the manufacture of purely synthetic organic products from coke or gaseous hydro-carbons.

More than 3 million tons of coke are consumed annually, but less than one-fourth comes from domestic gas and coke works. Nearly 3,000 tons of benzene and smaller quantities of toluene and crude naphthalene are obtained annually as by-products from these works.

Manufacture of synthetic ammonia from coke was begun during the last war, at Köping, for the production of nitrogeneous fertilisers at Kvarntorp, which will utilise some 14,000 tons of surplus gas and steam from the Government-owned shale oil plant. In this plant part of the shale is distilled in the earth, *in situ*, through electrical heating. Products obtained consist mostly of benzene, fuel oil, liquefied butane and propane, and sulphur of high purity, about 50,000 tons annually. Most domestic nitrogenous fertilisers come from the electrochemical industry.

Organic chemicals industry's prospects

The manufacture of organic chemicals is based mainly on carbide and chlorine produced electrochemically, and on alcohol which is produced in large quantities in sulphite cellulose plants. Some methanol is obtained as a by-product in making charcoal and sulphite and sulphate cellulose, but most of the supply is obtained from abroad. Gas and coke works meet most benzene requirements, but imports are required to meet most of the demands for toluene, phenol, cresol and naphthalene.

The organic chemical industry which came into existence in Sweden just before the second world war had to contend not only with high tariffs and total import prohibitions abroad but also with the disadvantage of weak protection from foreign competition in the home market. Should domestic consumption rise, Swedish production of several organic chemicals is likely to be started and/or expanded.

Materials for plastics and paint industries

The manufacture of moulding powder and resin from imported phenol and cresol was begun around 1920 at Perstorp. Moulding powder, gums and glue are now produced from melamine and urea in Sweden. The nation's requirements for melamine are met with calcium cyanamide and dicyanamide obtained from carbide. Urea is also manufactured domestically from ammonia and carbon dioxide. Formaldehyde, used in making the plastics just mentioned, is produced mainly from imported methanol, and a considerable amount of formaldehyde in aqueous solution is exported.

In the field of thermoplastics, Sweden has a productive capacity of 3,500 tons of polyvinyl chloride from carbide and chlorine, which covers

approximately the needs of the country. Some methacrylate is produced domestically from acetone, hydrocyanic acid and methanol, but the greatest source are the imports of the monomer product. Polystyrene is manufactured from imported monomer styrene.

The demand for alkydes for the paint and varnish industry is met primarily by domestic manufacturers, who also export some quantities. The most important raw material is phthalic anhydride, manufactured from imported naphthalene. Large amounts of this anhydride are also used in making plasticisers for the plastics industry together with butanol and cotanol produced from sulphite alcohol such as glycols, acetic acid, and esters of this acid. Manufacturing of acetone direct from alcohol has recently begun. Trichlorethylene and other chlorinated hydrocarbons are manufactured from carbide and chlorine.

Various kinds of soluble cellulose ethers which are becoming increasingly important are manufactured (by cellulose companies) from cellulose, alcohol, chlorine and alkali. Cellulose is also the basis of a fairly large production of nitrocellulose used by the explosives and varnish industries, and of rayon staple, rayon yarn and other viscose products.

Detergents and explosives

Manufacture of detergents and allied products is developing. Domestic raw materials are fatty alcohols and ethylene oxide, but imported alkylated aromatic hydrocarbons and similar materials are also used.

The organic chemical field also includes the explosives industry founded by Alfred Nobel. The rapid growth of this industry has been encouraged greatly by the expansion in mining, but exports of military explosives are also important. The manufacture of TNT and other explosives led Bofors Nobelkrut to initiate production of chemicals based on benzene, toluene and phenol for civilian use. It now produces a number of important aromatic intermediates and pharmaceuticals, some of which are mainly exported. Several other companies that primarily manufacture heavy chemicals also produce certain fine chemicals such as pesticides.

Only a few branches or products of the Swedish chemical industry are represented in the exports. Sweden is, of course, well known as an exporter of matches and there is a large trade in explosives. The following chemicals are exported in considerable quantities: aluminium sulphate, hydrochloric acid, sulphuric acid, glue and arsenious insecticides.

Pharmaceutical chemicals

The pharmaceutical industry, once engaged primarily in the compounding and packaging of prepared drugs, is now a sizable chemical industry. Such important antibiotics as penicillin and streptomycin are manufactured, and intensive microbiological research has been carried on for many years. The pharmaceutical industry receives its principal support from medical and biochemical research, in which Sweden occupies a leading position despite her relatively limited resources. The industry has managed to secure a satisfactory export market for several new products including antibiotics.

Atomic energy

The second Swedish atomic reactor and a large research centre in connection with it have now taken shape in preliminary designs, and 375 acres have been acquired in a sparsely populated district on the Swedish east coast just south of Stockholm. Construction will begin on the Kr.30-million plant this summer. A staff of 1,000 will be employed at the 10,000-kw. station.

Conclusions

The Swedish chemical industry today employs more than twice as many workers as in 1939, and there are reported to have been fourfold increases in the number of chemical engineers and in laboratory and office staffs.

The country is self supporting in a very wide range of chemicals and, in spite of high protective tariffs and quota restrictions, exports have increased five- to six-fold.

Acknowledgment

The writers wish to acknowledge the assistance of information issued by Swedish official sources and the Swedish Chemical Industries Association.

Producing Images of Chemical Molecules

The evidence for the existence of atoms, although overwhelming, is essentially indirect in that, up to the present, nobody has devised a way of presenting to the eye an image in which separate atoms can be seen. Light has too long a wavelength, the electron microscope still falls far short of atomic resolution and *x*-rays cannot be focused.

X-rays, however, have produced the nearest approximation for, under certain conditions, it is possible to *compute* the form of the image of a crystal from observation of the way it diffracts *x*-rays. The computations are usually long and tedious and it was the purpose of a discourse by Prof. H. Lipson at the 40th Physical Society Exhibition, held in London recently, to describe methods of replacing the computations by experimental work.

The methods depend upon the conversion of the *x*-ray data into an equivalent set of beams of light; since *x*-rays cannot be focused and light can, these beams can be passed through a lens and at the focus an image of the crystal should be seen. The experimental requirements are that a number of parallel light beams should be produced with relative dispositions, intensities and phases that simulate the *x*-ray beams diffracted by the crystal. The interference pattern produced when these beams are brought to a focus by a lens—the Fraunhofer diffraction pattern—is then an image of the atomic structure of the crystal.

Various methods of carrying out these experiments were described and were illustrated by results for several different crystals. The possible place of the techniques in the armoury of the *x*-ray crystallographer was discussed.

Tanks, Pits and Vats —Make Them Safe

(*Concluded from page* 266)

enters with a rope round his waist controlled by another worker outside the tank. The apparatus must be of the air-fed or self-contained type. A canister respirator is inadequate.

If the container is capable of being filled with water, the CO_2 can be pushed out bodily; if not, as CO_2 is soluble in water, it may be possible to clear the gas by using hoses—a technique extensively used in the brewery trade.

All equipment likely to be used in tanks, pits, vats, etc., must be meticulously covered by safe working codes. As far as possible the use of portable lamps should be avoided, but where that is impracticable they must be of intrinsically safe pattern, or of flameproof construction. In order to remove the hazard of electric shock they should be provided with low-voltage current.

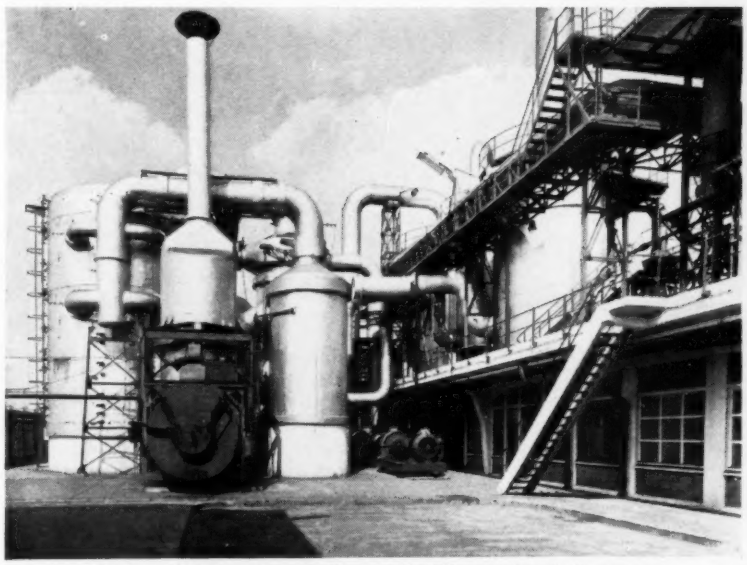
Sulphuric Acid Manufacture by the Contact Process in France

MODERN PLANT REPLACES LEAD CHAMBERS

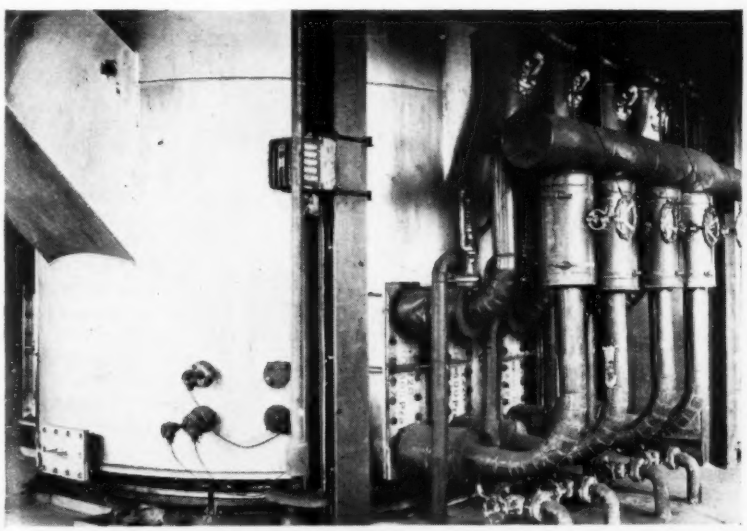
The latest pyrites roasting and catalytic techniques are embodied in a new plant at Dieuze for the manufacture of sulphuric acid by the contact process. Here is a description of the plant, novel features of which include the heat-exchange unit.

AT the Dieuze chemical works in the east of France, workmen were recently battering down the last walls of a lead chamber plant which had been producing sulphuric acid since 1870. Before the plant closed down, the daily production amounted to 70 tons. A pioneer plant using the contact process and supplying 30 tons/day of sulphuric acid was built in 1928. These two old plants have now been replaced by a most modern plant, housed in big new buildings, using the latest version of the contact process and producing 150 tons/day.

Important parts of the new plant are a fluidised-bed roasting furnace, a heat-exchange unit and a series of converters built according to the latest Kuhlmann patent. The vanadium pentoxide used to catalyse the oxidation of sulphur dioxide (SO_2) to sulphur trioxide (SO_3) by atmospheric oxygen is also manufactured in one of the Kuhlmann works in the north of France.



A view of the Kuhlmann plant at the Dieuze chemical works.



Pyrites roasting furnace.

Roasting of pyrites

The sulphur dioxide required for the contact process is made from pyrites, a naturally occurring impure iron dioxide (FeS_2), obtained from the Sain-Bel district near Lyons or, to a smaller extent, imported from Spain, Portugal and Cyprus. The pyrites, which arrives at the works either powdered or granulated and with a diameter up to 12 mm., is first dried (if necessary), sifted and pulverised. The machinery includes a drying chamber, a strainer, a pulveriser and transport apparatus such as vibrators, conveyor belts, shaking chutes, etc.—all remote controlled.

The pyrites is brought by rail into the storehouse and unloaded with the help of two electric travelling cranes, each of 3 tons' capacity. Here, 1,200 to 1,400 tons of pyrites can be stored. The storehouse also contains machinery which will—if necessary—

reduce the particle diameter of 300 tons of pyrites to less than 6 mm. within 24 hr.

From the storehouse or from the 100-ton silo the pyrites is sent to the furnace where, owing to its fineness, it can be roasted by means of the fluidised-bed process. The feeding of the furnace is automatic; 100 to 110 tons/day of the mineral are roasted, the exact amount depending on the sulphur content of the pyrites. The temperature rises to about 800 to 900°C. If everything goes right, the gas leaving the furnace contains 12 to 14% sulphur dioxide together with small quantities of sulphur trioxide and oxygen. The air required for the combustion of the pyrites is blown into the furnace by means of a 110-h.p. fan, which can supply 15,000 cu.m./hr. of air.

Heat exchanger

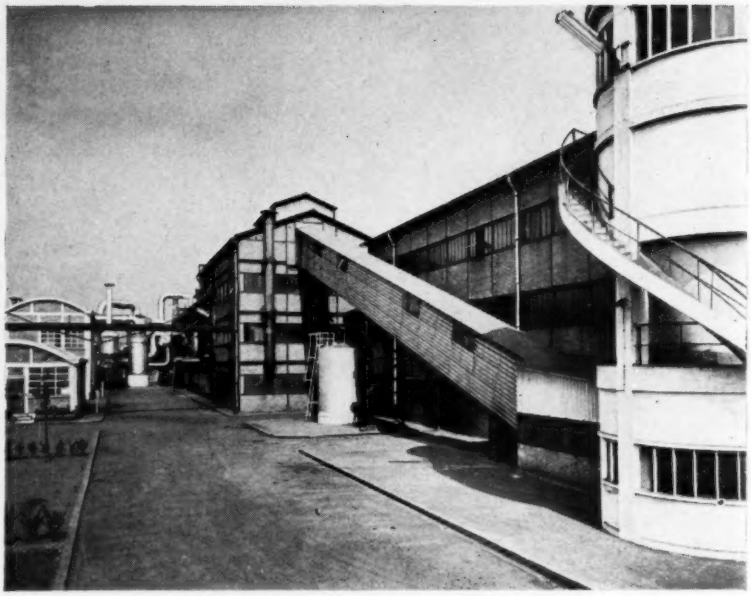
A novel and interesting feature of this plant is the heat-exchange unit. It removes the heat which otherwise would decrease the yield, and consists of a steam boiler of the forced-circulation type producing superheated steam of 380°C. and 28 kilo pressure. Most of the steam is used for the production of electricity and for the evaporation of salt solutions. In this way heat which formerly was a nuisance and required considerable quantities of cooling water is made to do useful work.

The boiler feed water is softened first, as the water of the district is rather hard. As a fuel, pyrites is a rather poor material. On burning it produces 1,400 to 1,500 cal./kilo, *i.e.* only about one-fifth of the heat produced by burning coal, but it yields a gas which is of much greater industrial importance.

The main advantage of the heat exchanger is, of course, the cooling of the furnace gases before purification. The fine dust particles in the gas are removed by electrostatic precipitation. The discharged dust particles—mainly ferric oxide Fe_2O_3—fall into collecting hoppers and are sold to iron works, where they are mixed with the blast furnace charge. The functioning of the furnace and the boiler is supervised from a special control room equipped with pyrometers, SO_2 determination and registration apparatus, etc.

Purification and catalysis

After removal of the dust the gas enters the rotary gas pump, which drives the gas through the plant. Then it is washed with a 60% sulphuric acid, which retains all traces of sulphur trioxide. During the washing the acid also takes up arsenic, which makes it unsuitable for many purposes, but it can be used for the manufacture of superphosphate. Acid mist is removed by wet electro-filters.



Another view of the sulphuric plant at Dieuze.

Finally the gas arrives at the converters where, in presence of a catalyst, the sulphurous anhydride, SO_2, is converted into the sulphur anhydride, SO_3—the higher oxide of sulphur—which eventually is turned into sulphuric acid $SO_3.H_2O$ or H_2SO_4. Before entering the converters the gas meets a stream of concentrated sulphuric acid trickling down a drying tower and removing any moisture from the gas.

From the converters the fumes pass to the absorption towers, where the reaction between sulphur trioxide and water takes place. But sulphur trioxide dissolves much more smoothly in sulphuric acid than in water. The fumes therefore enter the base of the tower and meet a stream of concentrated sulphuric acid descending over the packing. Oleum or fuming sulphuric acid with any desired percentage of sulphur trioxide as well as ordinary commercial concentrated sulphuric acid can be made in this way. The daily output of the plant amounts to 150 tons of H_2SO_4.

Only plant of its kind in France

When the new plant at Dieuze was built, use was made of the latest developments in roasting and catalysis. The plant is certainly the only one of its kind in France and probably one of the most modern sulphuric acid works in Western Europe. The products include oleum with 20% free sulphur trioxide, and sulphuric acids of 96 to 98%, 92.3% and 78%. The quality allows competition with foreign makes even in the export markets.

In order to obtain a first-class quality, the water which is used to bring the oleum down to the desired concentration is first completely demineralised. The cooling water is chlorinated to prevent alga development. After use it is cooled to 20°C. and returned to the cooling units. Only 6 to 8% of the cooling water is lost by evaporation and has to be replaced. Electro-filters, gas production, acid production and acid concentration are under remote control and all operations go on continuously.

Safety and other considerations

In case of any leakage, detectors placed in the main pipes give the alarm. Acid liquids are collected in a storage reservoir and are neutralised before being passed into the drainage system. The gases which are allowed to escape into the atmosphere are also perfectly harmless, since all noxious constituents have been extracted for economic reasons.

The main users of the sulphuric acid made at Dieuze are the metallurgical industries of Lorraine and the Saar Basin (especially for pickling) and the manufacturers of petrochemicals and artificial silk in Alsace.

A Full-Scale Nuclear Power Plant for Pennsylvania

(Specially Contributed)

Construction of the Shippingport atomic power plant in the United States is now well under way and production of electricity for the Pittsburg, Pa., area is expected to start next year. The plant, described in detail in this article, incorporates a pressurised water reactor and employs some unusual materials of construction.

THE Shippingport power plant is sponsored by the United States Atomic Energy Commission to further the peace-time use of atomic energy in the field of electric power generation. The design, construction and operation of this full-scale nuclear-power plant, carried out by Westinghouse Electric Corp., will provide much knowledge in the fields of reactor physics, fuel element and core technology, and component and system design. By actually designing, manufacturing, operating and maintaining the full-scale components required for such a power plant, future plants of a similar type can be developed and evaluated with greater accuracy. The plant organisation will serve as a pattern for the establishment of operation forces for nuclear power stations, and the facility will also provide training for personnel for future plants.

Reactor design

In this plant, the nuclear reactor is the heat source and produces a minimum full power rating of 790 × 10^6 B.Th.U./hr. This heat is produced in a nuclear core, which is a right circular cylinder consisting of assemblies of enriched uranium in clad plates and natural uranium in tubes.

The reactor plant consists of a single reactor heat source with four main coolant loops. Three of these loops are required for producing the 60,000-kw. minimum design power. Each loop consists of a single-stage, centrifugal, canned-motor pump, a heat-exchanger section of a steam generator, 16-in. gate-type isolation valves, and the necessary 18-in. outside diameter interconnecting piping (Fig. 1).

High-purity light water serves as both coolant and moderator in this plant. This water is under a pressure of 2,000 p.s.i. The flow through the nuclear core is 45,000 gal./min. for three loops. At full power the inlet water temperature to the reactor is 508°F. and the outlet temperature is 524°F. The water velocity in the 18-in. pipes is approximately 30 ft./sec., with a velocity of between 10 and 20 ft./sec. in various parts of the nuclear core. The total pressure drop around the main coolant loop is 105 p.s.i., and this drop is divided roughly equally between core, steam generators and piping.

The coolant enters the bottom of the reactor vessel where 90% of the water flows upward between the fuel plates and rods, with the remainder by-passing the core so as adequately to cool the walls of the reactor vessel and the thermal shield. Having absorbed heat as it goes through the core, the water leaves the top of the reactor vessel through the outlet nozzles. It then passes through two 16-in. isolation valves in series and goes through the heat-exchanger section of the steam generator. The water then flows through the canned-motor pump and back through the inlet isolation valves to the bottom of the reactor vessel, completing the cycle.

Isolation valves are located immediately adjacent to the reactor inlet and outlet nozzles of each of the four loops. These valves permit isolation of any loop of the reactor plant, to provide maximum protection to the reactor and so that maintenance can be performed while the remainder of the loops are in operation. Adequate shielding is provided to permit this.

The main coolant flows through the inside of many hundreds of small stainless-steel tubes in the heat-exchanger section of the steam generators. These heat-exchanger tubes are surrounded by the water of the secondary system, which is heated by the primary coolant in the tubes. Wet steam is formed, which passes upward through the risers and enters the steam separator portion of the steam generator. Here the moisture is removed and returned to the heat-exchanger section through the downcomers. The

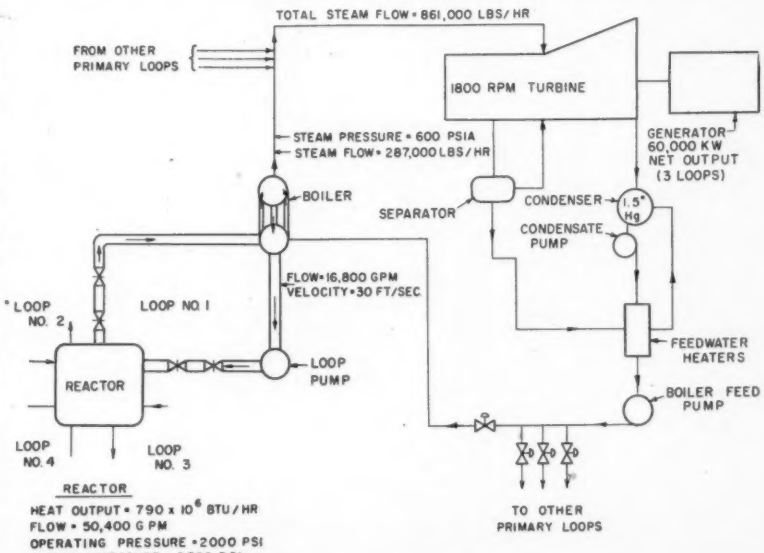


Fig. 1. Heat and coolant diagram.

dry and saturated steam at 600 p.s.i.a., at full power, leaves the top of the steam separator and goes to the steam turbine.

Great improvements probably can be made in the nuclear cores for this plant. To take advantage of this, the reactor vessel and the primary coolant system have been arranged to accommodate cores considerably larger than the first and with flow and pressure drop requirements covering a broad range. It is expected that sufficient information will be obtained from the operation and test of the first core so that subsequent cores may produce sufficient heat energy to be compatible with the 100,000-kw. rating of the turbine generator.

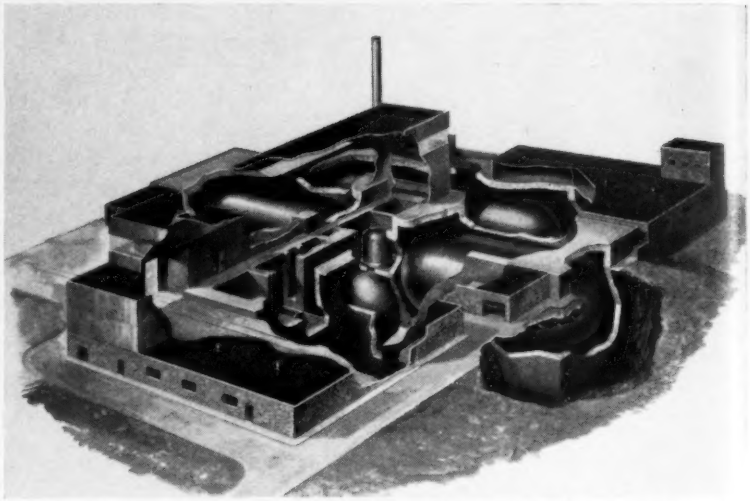


Fig. 2. View of the various sections of the Shippingport plant, showing major plant components.

Layout of plant

To restrict the spread of radioactivity in the event of a dual casualty (*i.e.* rupture of the primary coolant system and subsequent melting of the nuclear core with attendant release of fission products) the nuclear part of the plant is completely inside a steel container. This steel container is sized to contain the pressure created by a rupture of the primary coolant system of the most adverse size, including the effect of the stored energy in the water and the metal, as well as any conceivable energy release due to a zirconium-water reaction.

The plant container is divided into four units connected by large, tubular ducts. The reactor vessel is located in a spherical section, while two of the main coolant loops are in each of the adjacent cylindrical sections. The fourth cylindrical section is connected into the other three and contains the pressurising and other auxiliary systems (Fig. 2).

The reactor vessel has an overall height of 33 ft., with a cylindrical section having an internal diameter of about 9 ft. and a nominal wall thickness of 8½ in. The total estimated dry weight of the reactor vessel is 250 tons. The vessel is formed of carbon-steel plates and forgings with stainless-steel cladding (Fig. 3).

A canned-motor pump in each loop circulates coolant. The pump utilises a single-winding motor of 1,200-kw. capacity, which can be connected for two speeds. Power supply is 2,300 v., 60 cycles/sec., three-phase for both speeds. The motor, weighing about 20,000 lb., is mounted in the cast stainless-steel volute with a seal-welded joint.

Two hydraulically operated main stop valves are required in each loop, or eight for the plant. One is a parallel-disc gate valve, hermetically sealed and provided with an integral cylinder and piston type of operation. Latches hold it in the closed position. The nominal size of the valve opening is 16 in., with ports tapered to an 18-in. size.

Eight manual valves serve as back-ups for the hydraulically operated stop valves.

Steam generators

The steam generators are each rated at 263×10^6 B.Th.U./hr. and provide 600 p.s.i.a. full-power steam pressure; this pressure rises to 885 p.s.i.a. at no load. The second-side design pressure is 975 p.s.i.a. The primary side operating pressure is 2,000 p.s.i., with a design pressure of 2,500 p.s.i. Some 6½ million lb./hr.—or approximately 1 million gal./hr.—of primary cooling water passes through the tubes, entering at a temperature of 542°F. and leaving at 508°F. Two of these units are entirely of stainless-steel construction and are of a straight-tube, fixed-tube sheet design. They are 36 ft. long and 43 in. in diameter (Fig. 4). The other two units are of a return bend of U-tube type. The overall length is 28 ft. and the diameter is 39 in.

Steam generators of the two different types are used so that experience can be gained in the design, manufacture and operation of both types to give more knowledge on which to base the design of future plants.

The pressurising tank is 18 ft. high and 5 ft. in inside diameter, with a total volume of 300 cu. ft., of which about 150 cu. ft. is the steam dome volume with maximum water level. Normal surges will be as great as plus or minus 10 cu. ft. under design plant-load fluctuations. Under these design conditions primary system pressures will be held within limits of 1,850 to 2,185 p.s.i.a. A 6 in. surge line in the bottom head connects this tank with the primary coolant system.

Core design

The active portion of the nuclear core is in the form of a right circular cylinder 6 ft. in mean diameter and 6 ft. high. To minimise the amount of enriched U^{235} used, the core consists of some highly enriched seed and some blanket assemblies. The highly enriched, or seed assemblies, are located in a square annular region about 6 in. thick. The area inside and outside the annulus is filled with natural uranium-oxide sub-assemblies.

Each seed sub-assembly consists of several plates welded together to form a box. Four of these box-type units are welded together, with separation maintained by spacers, to form a central cruciform-shaped area. In each of these areas is located a cruciform-shaped hafnium control rod.

The uranium oxide or blanket assemblies use a rod as the basic element. These rods are *Zircaloy*-2 tubing. The tubes are filled with UO_2 pellets and have *Zircaloy*-2 end plugs welded to each end to form fuel rods. These rods are assembled into bundles of 100 rods each; the assembly is made by mechanically fastening together a stack of seven bundles, each about 10 in. long, for a total of about 6 ft.

A great many new and unusual

materials are employed in the design of nuclear reactors. The need for their use comes from the requirement that structural materials, heat-transfer fluids, shielding materials, and nuclear fuel and moderating materials must have certain nuclear properties. Numerous materials that, in the past, have been rare and little known from the standpoint of engineering properties are now being used in varying degrees.

Primary auxiliary systems

A number of auxiliary systems are connected into the primary coolant circuit to ensure proper operation of the plant. Some of these, such as the pressurising system and the purification system, are in use continuously, while others are required for intermittent operation. In addition, there are the usual power auxiliary systems such as cooling water, compressed air and electrical.

The coolant charging system is used for filling the primary plant prior to operation and for maintaining the proper fluid level in the pressuriser. One 100-gal./min. low-head pump is used for filling and two 25 gal./min. high-pressure pumps are required for the intermittent make-up function. The charging system also contains facilities for charging fresh resin into the purification demineraliser and back-flushing the primary loops. No purification equipment is provided in this system, as the water received from the boiler make-up water equipment meets primary water specifications.

Pressurising system

Changes in the core average temperature due to power excursions and changes in reactivity, and subsequent correction by control-rod movement, make the system coolant volume a variable. These volume changes would cause wide variations in coolant-system pressure if the plant were operated as a solid system. The function of the pressuriser is to regulate the system pressure within a lower limit set by the reactor hot-spot temperature, and an upper limit determined by the safety and relief-valve settings. Relief valves are expected to function during abnormal positive surges only. The pressurising system maintains a 2,000-p.s.i. saturation steam head in a separately heated pressurising vessel. This vessel has a volume of approximately 300 cu. ft., and contains about 100 cu. ft. of water. The heat to the pressurising vessel is supplied by 500 kw. of electric immersion heaters.

A fraction of the coolant that passes through the nuclear core must be purified to limit the activity build-up of the long-lived impurities in the water. This is done by passing a part of the coolant through a by-pass demineraliser, which removes soluble and insoluble matter. The reactor coolant-purification system consists of two parallel loops, each of which provides purification for two of the four reactor coolant loops.

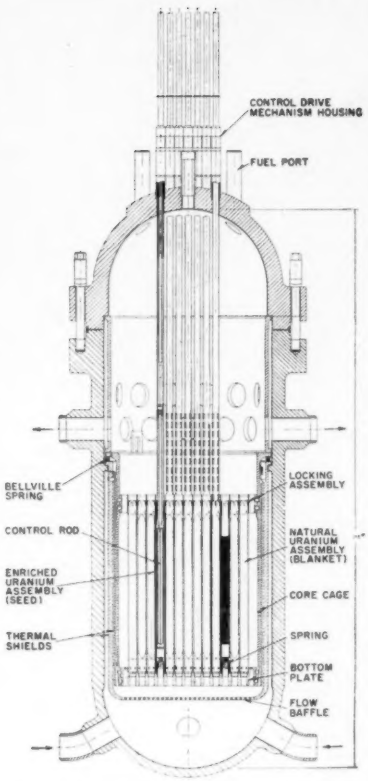


Fig. 3. Sectional diagram of reactor vessel.

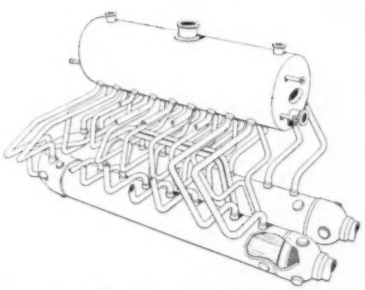


Fig. 4. Diagram showing construction of steam generators.

Reactor control

The reactor plant will be controlled to maintain a constant average temperature of the primary coolant. Therefore, the control method is one of average-temperature error detection and correction. On-off control of rods is initiated at $\pm 3°$F. error, with a $\pm 2°$F. deadband. Because of the slow response of the temperature-sensing elements and of heat transfer around the loops, the corrective action of the control would produce overshoot and oscillation of the system even if a considerably wider range of temperature variations were permitted. For this reason a damping effect is provided by incorporating the rate of nuclear level change into the control signal.

The normal mode of operation in the power range and during low-power standby is by automatic control of the rods, as described. Manual control can be employed by the operator if he desires.

Turbine generator plant

The non-nuclear portion of the Shippingport power station is unconventional in many respects, *e.g.* it utilises saturated steam at low pressure and this pressure is not constant but rises from 545 to 870 p.s.i.g. as the load is reduced; the station service power supply is, owing to the requirements of the nuclear portion, much greater than is customary for a plant of this kilowatt rating; the control must recognise that the heat source is a reactor; and, of course, there is no conventional boiler with its many appurtenances.

The turbine generator has a maximum capability of 100,000 kw. and is a single-cylinder unit. The turbine has three points of extraction for steam. All the steam leaves the turbine at the second extraction point and passes through a moisture separator and is returned to the turbine, the moisture being reduced from 11.6% to about 1%. The exhaust moisture will be about 13.2%. The cylinder barrel between blade rows is lined with stainless steel, and all blades will be *Stellite* faced where the moisture content of the steam exceeds 6% and the blade tip speed exceeds 900 ft./sec. The gross turbine heat rate at 100,000 kw. will be 11,385 B.Th.U./kwh.

The turbine generator will be an outdoor type located on a deck, below which the condenser and auxiliary equipment will be housed. The station service busses will be arranged in four sections with one main coolant pump and certain other auxiliaries supplied from each section. A single control room will be provided in which will be centred the control, the

reactor and its appurtenances, the turbine generator station service and the outgoing power circuits. A pictorial board will be utilised, showing principal electric and piping circuits.

Load conditions

The Duquesne Light Co. system is a highly industrialised metropolitan system serving an area of 816 sq. miles which surrounds the city of Pittsburgh. The system capacity before the Shippingport power station is installed will be 1,207,000 kw. The system normally operates as part of a large interconnection with 32 million kw. of connected capacity extending through the entire east-control section of the United States. Each system of the interconnection must provide a minimum reserve capacity equivalent to 10% of the total installed capacity and provide an operating reserve equivalent to the output of the largest unit in operation. As the Shippingport station rating is less than the 150,000-kw. rating of the largest unit, the addition of the Shippingport station will not alter normal reserve requirements.

The system load characteristics are very erratic and variable, owing to the heavy steel load in the area. The system output must be rapidly changed through a range of 60,000 to 80,000 kw. at frequent intervals and at a rapid rate to balance the load requirements. The Shippingport station is designed to share in this responsibility.

The normal load changes required for manual operation or automatic operation with load control equipment are within the capabilities of the reactor portion of the plant and are equivalent to the performance required of a conventional boiler and turbine generator. The Shippingport station is also designed to adjust its output during emergency conditions, such as the loss of the largest generating unit or the loss of a large block of system load without exceeding the safe operating limits of the reactor portion of the station.

The nuclear station can be started from cold shut-down in $3\frac{1}{2}$ hr. or within $1\frac{3}{4}$ hr. following an overnight shut-down, which is somewhat faster than a conventional steam plant.

Safety and manpower requirements

The radioactivity of the reactor requires precautions to ensure safety of the personnel. However, it is expected that a weekend shut-down will allow minor repair work, within the shielding, without hazardous exposure. The test programme planned for the first few years of operation may prevent maximum utilisation of the station due to the reduced output necessary for the conduct of certain tests and inspections.

The preliminary schedule of manpower for the Shippingport station indicates that 130 employees are required; 49 of these would not be required for normal operation. This leaves a minimum organisation for normal operation of 81 employees, compared with 66 required to operate a 100-mw., single-boiler, single-turbine plant recently placed in service. The operation of the first commercial nuclear power station requires that the personnel be thoroughly trained before the start of operations. A training programme starting two years before the initial operation of the plant is in progress. This programme involves classes in nuclear physics, radiochemistry and other related subjects, field operation and maintenance experience at an experimental nuclear test plant and, for certain personnel, design experience on the Shippingport power station. All employees will be given minimum training in health physics and security control.

Nuclear Reactor Maintenance

Valuable Experience Gained at Windscale

THE reactors at the Windscale works of the United Kingdom Atomic Energy Authority are graphite-moderated and air-cooled and when they were being designed it was assumed that, after the reactor went into operation, radiation and induced radioactivity would make the core of the reactor and its immediate vicinity inaccessible. Therefore, a basic design principle was to locate engineering equipment outside the biological shield as far as possible and to make equipment inside the shield stationary. Also, means of access through the shield would not be provided and the inspection holes in the roof of the biological shield would be kept small to minimise radiation leakage.

As the main exception to the general rule, the burst cartridge detection gear —a substantial stainless-steel structure —is inside the shield and moves vertically up and down the back face of the graphite lattice.

Over a period of time those items contained within the reactor proper, and which had been subjected to the influence and effect of flux, temperature and air flow, developed faults and therefore unusual, and to some extent unexpected, maintenance work has had to be done under reactor conditions. Each problem, as it presented itself, was novel, and therefore special techniques had to be evolved to carry out what were in themselves simple mechanical operations, but which were rendered difficult by the unusual circumstances and the hazards.

After a brief discussion of these circumstances in a paper presented to the Institution of Chemical Engineers in London, Mr. H. G. Davey, O.B.E., M.SC., M.I.CHEM.E., works general manager at Windscale, gives some examples of the maintenance and other work which has been done there, and of the techniques which have been evolved. In doing so, he points out that during the last $5\frac{1}{2}$ years these reactors have given remarkably little trouble and, in fact, have been in production for 93% of the possible time. Thus, although from time to time problems have arisen which constituted a challenge to ingenuity, they have not caused prolonged shut-downs.

Remote-control welding

A serious difficulty was experienced with one reactor when the driving motor of the burst cartridge detection gear came out on overload and, after shutting down the reactor, an inspection was carried out. One scanner arm was seen to be fouled by the top edge of a plate which had become loose and was bent away from the graphite face. It was decided to try to force the plate back into position and to retain it in position by using articulated rods. It will be realised that, by working remotely through the 4-in. holes, only limited force could be applied to the plate and attempts at straightening were unsuccessful. It was then decided to try to cut the plate with a welding torch. An oxy-acetylene torch was lowered through a 4-in. hole and observed and directed

by means of an introscope inserted through an adjacent 4-in. hole. The plate was roughly cut for the greater part of its vertical length and, thus weakened, was returned to position without great difficulty and held there with rods.

This, and similar work involving the use of a welding torch, inspired a much more ambitious programme. Could reasonable welding precision be attained in such circumstances? Would spot welding of bolt heads and welding of plates to one another and to curtain rails be possible?

A full-scale mock-up was constructed which simulated exactly the conditions under which the repairs would be carried out, and enabled practice to take place under inactive conditions. Over a period of a few weeks, satisfactory tools and techniques were evolved and welders adapted themselves to the strange working conditions.

Repair work has been carried out on both reactors and, to date, 121 bolts have been spot welded and 108 strengthening welds have been made. The baffle plate assemblies as a whole are now adequately mechanically strengthened and development work is proceeding to undertake welding and the replacement of a few missing plates from even more remote positions.

Direct work with temporary shielding

When cartridges are discharged from a reactor they fall vertically from the back face of the graphite lattice into trucks or skips located in the water duct. While the reactor is operating a train of skips is always in position and immediately after a scheduled shut-down the train is withdrawn and the skips are inspected. This rule was introduced to check on the blowing out of cartridges during normal operation.

During such an inspection a scanner guide shoe bracket with four holding bolts, sheared and still in position, was found in a skip. The shoe itself had been sheared off where the 2-in.-diameter pin entered the bracket and the shoe was missing. This was a discovery of great significance and with potentially very serious consequences.

Inspection confirmed that the right-hand bracket of the No. 7 scanner was missing and that the guide rail bolted to the scanner had broken loose; the remainder of the brackets and guide rails were in position. At the same time a radiation survey was carried out and the general level near the floor of the water duct was 80 r/8 hr.

The matter was serious because of the function of the burst cartridge detection gear. This gear, which consists essentially of eight scanners, is vital to the reactor operation. It gives an early indication of a cartridge failure and thus enables the faulty cartridge to be discharged before the burst can develop to a point where radioactive contamination of the back of the reactor might occur.

It was recognised that replacing the original bracket and tightening the guide rail was out of the question, since they were located in a field of high radiation intensity. A suggestion was made that some form of roller, bearing on the back of the aero foil section of the scanner frame, should be fixed to a long arm and the lower end of the arm be bolted to the wall of the water duct by a diver. The suggestion was accepted in principle, but it was agreed that the work could not be done by a diver. Ultimately, an initial plan was evolved for prefabricating rollers on a frame and installing this frame by working in the dry duct under temporary shielding.

Mr. Davey's account of how this was carried out is an inspiring story of careful and detailed planning and of painstaking rehearsals of the operation. Investigations into plate sizes and handling problems showed that it would be possible to suspend a plate 2-in. thick × approximately 16 ft. × 5 ft. wide from the outer roof inspection hole using the reactor crane already installed. An end shield could also be suspended from the inner west inspection hole and dropped into position so that the lower end rested on the floor of the duct whilst the upper end leant against the roof shield thus forming, with the sides of the duct and the end wall of the discharge area, a box inside which work could be done. In practice, many snags had to be overcome before the work was completed. An unexpected difficulty was in the erection of the roller guide bracket. This was due to the awkward shape and size of the bracket and the restriction to movement imposed by the shield props and bracing. The bracket had to be dragged along the duct wall in a horizontal position and lifted by means of a winch rope into a vertical position. It was then hoisted and bolts put in at the bottom. The front shield plate had to be removed to allow the top fixing bolts to be located and here difficulty was experienced. The bracket was unbolted, the front shield plate lowered to the floor of the duct and the bracket refixed. An attempt was made to drill the eight holes at the top of the bracket, but because of the unforeseen irregularity in the concrete facing behind the lower thermal shield plates the drilling was unsatisfactory.

It was then decided to fix a rigid M.S. backing plate against the thermal shield plate with four ¾-in. *Rawlbolts* located between the two arms of the roller guide bracket. After final adjustments had been made and the alignment of the bracket was satisfactory, the plate on each arm of the bracket was welded to the fixed plate.

After fixing was complete, the roof shield doors were opened and the scanners were wound down by hand. It was not possible to do this completely because scanner No. 3 fouled the top of the roof shield, but the test was sufficient to prove that the bearing was accurately installed and fulfilling its function.

General experience with reactor maintenance

Experience has shown that high radiation levels can often be dealt with without providing heavy and elaborate shielding. The utilisation of distance and time is an acceptable alternative provided suitable tools and techniques can be developed.

Frequently major difficulties have been due to limited visibility and accessibility. The Windscale reactors are now well equipped with introscopes, a periscope and a television camera, but there are regions which cannot be viewed and, occasionally, operations and observations have to be conducted simultaneously through the same hole.

It is important to provide accurate, detailed, record drawings of reactor construction, even if, at the time of construction, it is considered that some regions, ultimately, will be inaccessible.

The design and fabrication of temporary shielding which has to be erected in confined spaces within a specified short time must be executed with the greatest care. All operations should be practised to give the men confidence and to reduce to the minimum the time during which they will be exposed to radiation. Where appropriate, mock-ups should be built to simulate the conditions under which the work will be carried out.

Sufficient experience is now available to permit a reactor to be defined as a maintainable unit and this will have a fundamental effect on the design of future reactors.

A Chemical Works in Iceland

NEW PROCESS USED IN AMMONIUM NITRATE MANUFACTURE

TWO years ago Iceland made the first step towards establishing a chemical industry on a large scale, when the Aburdarverksmidjan works at Gufunes near Reykjavik started to make ammonium nitrate. Little has been known about Iceland's first chemical works, until R. Thordarson, a chemical engineer and the technical manager of the firm, described the plant in great detail in a recent number of the Danish periodical Ingenioren. *A brief summary of the processes involved appears below.*

The chief raw materials are air and water, although cheap electrical energy is essential to convert these raw materials into a valuable fertiliser. Kieselguhr required for coating the ammonium nitrate crystals is imported from Denmark. Sodium and potassium hydroxide and hydrochloric acid are used in relatively small quantities and also imported. The ammonium nitrate is made in five steps.

Manufacture of hydrogen

Hydrogen is produced by the electrolysis of a 28% potassium hydroxide solution at 410 v. in 384 cells each having 13 cathodes and 12 anodes. The water for the electrolysis is thoroughly demineralised. The plant receives its electrical energy as alternating current at 33,500 v., and mercury arc rectifiers convert the alternating current into the direct current required for the electrolysis.

The firm does not own the power station, but buys the electric energy from the Sogsvirkjunin hydroelectric power station, which also supplies electricity for Reykjavik and south-eastern Iceland.

A remarkable feature in the operation of the hydrogen plant is the large use of off-peak energy, which is the basis for the economic soundness of the whole project. Aburdarverksmidjan gets a certain amount of energy as prime energy and, in addition to that, whatever is left over after the energy demand of the communities in question has been fulfilled and which the plant can use.

The hydrogen plant is therefore operated at widely varying loads with a great part of the hydrogen production taking place during the night. For this reason a relatively large gasholder has been erected. This is of the dry-seal type and has a capacity of 11,500 cu.m.

Nitrogen manufacture

Nitrogen is made by the distillation of liquid air in a plant supplied by L'Air Liquide, France. Filtered air is compressed to 15 kg./sq.cm. Carbon dioxide is removed by scrubbing with caustic soda solution, and moisture by absorption on silica gel. The air is then cooled by heat exchange and expansion until it liquefies. The liquid air is sent to a double distillation column, where gaseous nitrogen is drawn from the top.

Ammonia plant

Hydrogen and nitrogen are drawn from their respective gasholders in an automatically controlled ratio of 3 : 1 and mixed. The mixture is then compressed to 300 to 350 kg./sq.cm. in two five-stage compressors driven by 750-h.p. electric motors, filtered and sent to the synthesis loop. In this loop the synthesis gas is continuously circulated over a doubly promoted iron catalyst at about 500°C. The ammonia is removed from the gas mixture by condensation in a water-cooled condenser. The residual gas which contains some uncondensed ammonia is returned to the catalyst chamber.

Nitric acid

Ammonia is burned with air in the presence of a platinum-rhenium catalyst. The nitric oxide formed is oxidised to nitrogen peroxide, which is passed into a series of absorption vessels and finally into an absorption tower. There it meets a counter-current of nitric acid, which becomes gradually stronger, after it has started as demineralised water at the top of the absorption tower. The ammonia oxidation takes place at 870°C., the absorption at a low temperature, and part of the cooling is done by passing the mixture through a waste-heat boiler, which generates a large portion of the steam required in the works. The absorption plant is made of stainless steel.

Manufacture of ammonium nitrate

It is stated that a new process has been developed for the manufacture of the ammonium nitrate fertiliser. The ammonia is first dissolved in the mother liquor and then passed into the reactor, where it is mixed with 60% nitric acid. The heat of reaction is used to evaporate some of the water under reduced pressure, until the ammonium nitrate solution formed is nearly saturated. It is then sent to a crystalliser, where supersaturation is produced by further cooling and evaporation under reduced pressure. Ammonium nitrate crystals are formed and grow in the solution.

Full-size crystals are continuously drawn off with mother liquor from the bottom of the crystalliser. They are separated from the solution in a basket centrifuge and dried, whilst the mother liquor is returned to the ammonia absorber, thus completing the cycle.

Dangers due to high temperature are negligible, as the crystallisation takes place at 36°C., and the highest temperature reached in the drier is about 80°C. This is one of the chief advantages of the new process.

The *p*H value of the solution in the reactor is only roughly controlled, but a final adjustment is made in a special tank between the reactor and the crystalliser. After leaving the drier the crystals are coated with 4% by weight of kieselguhr to ensure the free-flowing quality of the product.

The average daily production is 55 tons of ammonium nitrate containing 33.5% nitrogen. This is equivalent to about 6,500 tons/year of nitrogen. The ammonium nitrate produced consists of small single crystals and not of clusters forming hollow spheres as produced by older methods.

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.

Safer Manufacture of NITROGLYCERINE

The Biazzi nitrating unit which is now operating in the nitroglycerine factory of Imperial Chemical Industries Ltd. at Ardeer, in Scotland, greatly reduces space requirements and also makes possible the incorporation of a comprehensive system of safety devices. Remote control is an immediate prospect.

EIGHTY-FIVE years ago, Alfred Nobel established his Ardeer factory at Stevenston in Ayrshire for the manufacture of nitroglycerine. Today this factory, the largest in the Nobel Division of I.C.I., and the biggest of its kind in Europe, manufactures many other products, but a fundamental activity is still the production of explosives based on nitroglycerine. From the original process, which consisted merely of adding glycerine to mixed sulphuric and nitric acids in jugs, and stirring with glass rods, steady advances have been made, not only in quality and quantity, but in safety, for the manufacture of nitroglycerine has always been considered one of the most hazardous of occupations.

The latest advance was made a few months ago when operation commenced with a Biazzi continuous nitration unit (based on the design of Dr. M. Biazzi). This is much more compact than the Schmid continuous process that has been employed hitherto; it permits a great reduction in the amount of nitroglycerine present in the process at any one time, and it is capable of being adapted for operation by remote control. I.C.I. believe it to be the most advanced type of nitroglycerine plant in the world, but they point out that it is far from being the last word in development. Future progress must be towards making the plant even safer by still further reducing the amount of explosive in the process and by moving on, perhaps, from remote control to complete automation.

Seen here in the Ardeer plant are the three washing vessels connected with the separator. Beyond is the nitrator.

Continuous nitration unit

The Biazzi unit at Ardeer is designed for an output of 2,500 lb./hr. It is completely fabricated in polished stainless steel, the surface of which prevents accumulation of pockets of nitroglycerine, besides enhancing the appearance of the plant. The nitrator itself is cooled by a sealed spiral system of coils in which sodium nitrate brine at –5°C. is circulated during nitration to maintain the temperature at 10 to 15°C. Agitation is provided by a specially designed high-speed stirrer, which causes the emulsion to circulate around the cooling coils before it flows off continuously through an overflow to the separator.

Glycerine and the mixed acid, metered in the correct ratio, are both fed in at the top of the nitrator, while the emulsion of nitroglycerine and spent acid enters the circular separator at a tangent. This gives a rotating movement to the contents which helps to accelerate separation of nitroglycerine from refuse acid. The acid leaves at the bottom of the separator *via* a levelling device, and passes to a dilution vessel where a small amount of water is added to avoid the separation of any dissolved nitroglycerine. Indeed, it is only in the separator that nitroglycerine occurs in a free condition, and it is estimated that only 125 lb. of the 1,350 lb. in the room is in this state. All the rest is in emulsion.

From the separator, the acidic nitroglycerine flows into the first of three mechanically agitated wash vessels, where it is brought into contact

ARDEER FACTORY

Ardeer factory is the principal works of the Nobel Division of Imperial Chemical Industries Ltd. The site of the factory was selected by Alfred Nobel himself in 1871, and the factory first started operations in 1873. Originally occupying an area of about 100 acres and employing about 100 staff and workers, the factory has grown until today it occupies an area of about 2,000 acres and employs 7,000 staff and workers.

At one time the factory was mainly engaged in the production of blasting and propellent explosives. Between the two world wars, however, the explosives industry was reorganised and the manufacture of detonators, safety fuse and blackpowder was centralised at Ardeer.

In addition, manufacture today covers the production of such products as cellulose derivatives, ether, sulphuric and nitric acids, ammonium, potassium and barium nitrates, silicone resins, and various types of pesticide smoke generators.

with an equal volume of 12% sodium carbonate solution. A very fine emulsion is formed here, by the action of the high-speed stirrers and the baffles, and this emulsion flows from one washer to another, and so to the final storage house. The time spent in the washers is quite sufficient for the nitroglycerine to be completely neutralised.

Safety precautions

Apart from the efficiency of the process, the Biazzi unit is distinguished by its elaborate system of safety devices. These have been designed with four aims: to minimise the effects of a mistake by the operator; to attract the operator's attention to the irregular functioning of any part of the apparatus; to allow the operator to act in such a way as to minimise the effect of any such irregularity; and to set into action automatic counteracting devices, should the operator's intervention fail.

Thus nitration cannot commence unless the safety system is energised and the various rates of flow are correctly adjusted. During operation, green and red signal lamps light up according to the seriousness of the irregularity, indicating the cause of any alarm, while for certain extremely serious occurrences, the glycerine arm is automatically raised from its feeding position, and the mixed acid and glycerine pumps are stopped.

A close-up of the Biazzi separator. The emulsion from the nitrator passes to the separator tangentially, thus imparting a circular movement to the contents.

Finally, should the temperature of either the nitrator or the separator reach an ultimate safety level, the contents of both, and of the three washers, are discharged into drowning tanks where automatic steps are taken to keep the contents under control. It is, of course, also possible for the operator to drown the charges.

Control equipment

At present, the plant is operated by a control desk situated within the nitrating house, and it is hoped that by the spring of 1957 this will have been removed to a control house outside the unit's protective mound. Not only will duplicate instruments to those now on the unit be provided there, but two closed-circuit television chains will enable the operators to keep a close eye on everything that goes on inside the nitrating house. This procedure has been adopted in order that the operators may grow slowly accustomed to the idea of remote control, so that when they are finally removed from all physical contact with the unit they may know themselves to be as thoroughly in control as they know themselves to be now.

Chemical Industry and Research in Poland

POLISH production of phosphatic and nitrogenous fertilisers has trebled, while production of cement has more than doubled, since 1949. In 1955 the Kendrzecin chemical works made 500 tons/day of fertilisers. Their manufacturing programme includes a wide range of chemical products such as fatty acids, waxes, organic solvents, mineral acids and alkalis.

The quantity of phenol obtained from the middle oil distilled from coal tar in Poland is insufficient to meet the industrial demand for the manufacture of dyes, drugs and plastics. The Oswiencin (formerly Auschwitz) therefore make additional quantities of phenol by passing a mixture of chlorobenzene and steam over a heated catalyst. The same works produce synthetic benzene, methyl alcohol, plastics and insecticides.

These examples give some idea of the trend in chemical production in Poland, where the industry has expanded a good deal since the war. Discussing the progress that has been made, in the Polish periodical *Praroda* (' Nature '), A. E. Sergijenko also gives us a glimpse of the Polish research and development in this field. Most of it is done at the universities and at the research institutes of the Ministry for the Chemical Industry. Co-operation with similar institutions in the U.S.S.R. is facilitated by the fact that many Polish scientists of the older generation have studied at Russian universities and that, up to 1917, well-known Russian scientists taught at the University of Warsaw.

Chemical research in Warsaw

Poland's capital city is the most important centre of chemical research. Prof. Swientosawski, who occupies the Chair of Physical Chemistry in the University of Warsaw, is the head of a research team studying the theory of azeotropic mixtures and its application to the separation of hydrocarbons. The mechanism of the nitration of hydrocarbons by means of nitrogen oxides is investigated by Dr. Urbanski, Professor of Organo-Chemical Technology in the Technical University of Warsaw. Prof. Wanda Polazkowa and her assistants are spending a considerable amount of effort on the development of synthetic processes in the field of organic chemistry. The Polish capital has also recently been chosen as the most suitable place for setting up a new institute for research on the chemistry and technology of plastics.

Gliwice and Lublin centres

The second most important centre of chemical research is Gliwice (formerly Gleiwitz), where a technical university was founded in 1945. More than 6,000 students are receiving their technical education here, and Prof. Leśnianski, who occupies the Chair of Organo-Chemical Technology, is well known for his work on the synthesis of detergents and the manufacture of phenol from iso-propyl alcohol. Prof. Czeslawa is concerned with research on condensation reactions of heterocyclic compounds. At Gliwice there are also the main laboratories of the National Research Institute for Chemical Synthesis.

At Lublin a university was founded in 1944, immediately after the Germans had left the town, but the building containing the chemical laboratories was only completed in 1953.

Important projects are under investigation in several laboratory divisions of the old University of Krakow (founded in 1364), where a new building has recently been erected for the Faculty of Chemistry.

Recent Publications

Centrifugal pumps. Leaflet No. 286A from Kestner Evaporator & Engineering Co. Ltd. describes and illustrates the company's centrifugal, positive and air-operated pumps and includes some notes on the installation and maintenance of centrifugal pumps. The company's latest acid pumps are not only glandless but also self-priming, while gland-type pumps, both of the vertical and horizontal centrifugal type, are also available for dealing with many corrosive liquids. For handling small quantities, there is a hand-operated semi-rotary pump, and motor-driven positive rotary pumps, while other interesting units include the *Oldbury* patent carboy discharger and the Kestner carboy syphon.

Arc-welded machinery construction in mild steel. From the British Welding Research Association comes a 36-page illustrated booklet which supersedes their publication T.18 and which, being a handbook of practical design for arc-welded machinery in mild steel, will be of use not only to designers and draughtsmen but also to students.

Non-destructive testing of steel castings is described and illustrated in a bulletin issued by the British Steel Founders' Association.

Polyester resins. British Resin Products Ltd. have recently published in booklet form an article entitled 'Recent Developments in Polyester Resins,' by H. Williams, B.SC., A.R.I.C.

Dished and flanged ends. A 32-page brochure, No. 965, issued by G. A. Harvey & Co. (London) Ltd., gives complete technical information about the firm's 'ends,' together with particular reference to a wide range of die-pressed dished and flanged ends normally available from stock.

Work study is the subject of the British Productivity Council's Action Pamphlet No. 7. This pamphlet summarises what work study is—a compound of work measurement and method study—how it is applied, how snags in introducing it can be avoided, etc.

Chlorine and caustic soda. Two new illustrated wall charts presenting up-to-date instructions for the safe handling of chlorine and caustic soda have been prepared by Olin Mathieson Chemical Corporation, U.S., for users and handlers of these chemicals. The charts are printed in large type on weatherproof, plastic-impregnated paper and are suitable for hanging in either outdoor or indoor areas where chlorine or caustic are unloaded or used.

INDUSTRY REPORTS . . .

German company's chemical interests

The annual report of Farbenfabriken Bayer A.G. (Germany) reveals that the company's share in the turnover of Western Germany's chemical industry as a whole in 1955 amounted to more than 10%. The company embarked on an extension of the large building programme initiated in 1954.

Production of polyesters and isocyanates started at the New Martinsville (West Virginia) plant of the Mobay Chemical Co., an undertaking established jointly with the Monsanto Chemical Co. of St. Louis, Missouri, for the production of the new polyurethane plastics.

In Brazil the company's interests were strengthened by taking over the Companhia de Acidos, Belford Roxo, near Rio de Janeiro. Measures for the rationalisation and expansion of production are now in hand, and the construction of new factories is being planned. The manufacture of azo dyes by Fábrica Argentina de Anilinas S.A.(ANILSUD), a company jointly owned by Cía. Químicia S.A. (a subsidiary of Bunge & Born, Buenos Aires) and Farbenfabriken Bayer A.G., began in March this year. Fábrica Argentina de Fenol y Derivados S.A. (FENSUD), in which the company holds a small interest, has been provided with a process for the manufacture of phenol.

Expenditure on research as a whole rose to D.M.62 million during the year.

The output of inorganic chemicals fell short of meeting requirements, and had to be supplemented by imports.

In the man-made fibre field, it was decided further to extend the plants producing *Perlon* and *Dralon*. Work is already proceeding, and the extensions are expected to come into service at the turn of the year.

Stabilised sulphur trioxide

Pressure on profit margins is illustrated in the results for Hardman & Holden Ltd. (Britain) and the chairman, Mr. K. G. Holden, states that increased competition compelled a reduction in some sales prices and the cost of many raw materials, fuel, services, wages and salaries continued the steady upward trend that has been a feature of the last few years.

Construction of a plant to manufacture stabilised sulphur trioxide under the trade name *Sulfan* has begun and it is hoped that production will commence during the early part of 1957.

Hydrogen peroxide project

Last year it was reported that Laporte Chemicals Ltd. (Britain) would erect a large-scale plant to manufacture hydrogen peroxide by an autoxidation process. The company is now settling the details of design and methods, and it is expected that the new plant will be in production by the beginning of 1958, according to the circulated statement of Mr. L. P. O'Brien, chairman of Laporte Industries Ltd.

More uses for tin

World production of tin in 1955, exclusive of the U.S.S.R. and China and Eastern Germany (for which figures are not available) was 168,000 tons of tin-in-concentrate.

This was revealed in the statement of Mr. W. M. Warren, chairman of the Council of the Malayan Chamber of Mines. He also commented on new outlets for tin and pointed out that probably the most potentially fruitful work now going forward is the extension of the chemistry of organotin compounds in which each atom of tin is combined directly to carbon atoms. These organotin compounds are infinitely more complex than the customary compounds of tin and some of them have quite unusual properties. One type that has been produced is toxic to fungi and successful large-scale trials with it have been in progress in Canada as a preventative of slime in wood pulp factories. Other fields for such organotin compounds would appear to be in the prevention and control of fungal attack upon wood, textiles, paints and varnishes.

Heavy chemicals and fertilisers in South Africa

At the annual general meeting of African Explosives & Chemical Industries Ltd. (South Africa) it was stated that, with the completion of certain extensions to the storage and handling facilities, now in progress, the aggregate capacity of the two fertiliser factories at Umbogintwini and Somerset West will be about 800,000 tons p.a. of superphosphate. These two factories will also be equipped to handle a larger tonnage of fertiliser mixtures both in powder and granulated form. The principle has also been approved of establishing a third superphosphate factory in the Union as and when this becomes necessary.

A. E. & C. I. (Rhodesia) Ltd. is

proceeding with the establishment of superphosphate manufacture at the Rodia factory, near Salisbury, Southern Rhodesia, which will include a granulation plant.

A new plant at Modderfontein in the Union has a designed capacity of 50,000 tons of ammonia, 60,000 tons of nitric acid and 100,000 tons of ammonium nitrate p.a., the total capital cost, excluding working capital, being nearly £6 million.

The different sections of the new plant at Umbogintwini for the manufacture of chlorine, solvents and plastics were started up satisfactorily during the latter half of 1955 and early 1956.

It has recently been decided that the company will join with British Titan Products Ltd. in the establishment in South Africa of the manufacture of titanium dioxide pigments. This undertaking will be established at Umbogintwini on a portion of the site of the existing factory, from which it will draw its requirements of sulphuric acid. The other main raw material used in titanium dioxide manufacture is ilmenite which occurs fairly widely in the sands of the Natal south coast.

Farbwerke Hoechst A.G. activities

The annual report of Farbwerke Hoechst A.G. (Germany) states that the new, modern, carbide furnace erected at the Knapsack plant of Knapsack-Griesheim A.G. substantially eased the raw material position in the field of solvents and plastics. Work began on the construction of a second and larger phosphorus kiln. In view of the technical development of apparatus and processes, considerable progress was made in the welding technique used by Knapsack-Griesheim A.G. for many years. New application methods were found for welding carbide, oxygen and other technical gases.

Expenditure of Farbwerke Hoechst A.G. on research and development amounted to approximately D.M.69 million during the year, equivalent to more than 5% of the total turnover. This shows that appropriations for this purpose have more than doubled since 1952. The number of personnel with scientific and technical training rose to 1,400 by the end of the year.

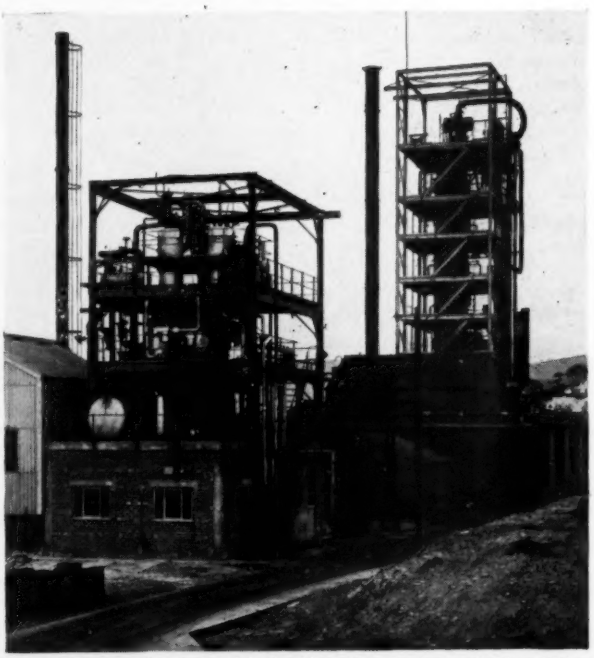
The entire capital of Anorgana GmbH., Gendorf, was acquired during the year and the plant continued working as part of Farbwerke Hoechst A.G. as from October 1, 1955.

New Chemical Plant in Lancashire

AN opening ceremony which took place at the plant of Hess Products Ltd., at Littleborough, Lancs., inaugurated the production of a range of chemicals which have been made in the United States for some years by Armour & Co., Chicago. At the opening ceremony were many friends of Armour & Co. Ltd., London, and Hess Products Ltd., who acted as joint hosts, and including representatives from industry, commerce, the academic world, research institutions and other bodies. Mr. S. R. H. Fletcher, chairman of Hess Products Ltd., and Mr. N. Hess received the guests, amongst whom were Mr. T. D. Lively, managing director of Armour & Co. Ltd., London, and Mr. J. M. Hoerner, general manager of the Armour Chemical Division, Chicago.

After the opening ceremony the guests had an opportunity of visiting the factory, including both the new plant and the fractionation unit, producing *Distec* fatty acids, the latter unit having been in operation for over five years.

The new plant, described briefly in CHEMICAL & PROCESS ENGINEERING, 1956, **37** (3), 95, utilises raw materials supplied by the older plant. Ammonia and fatty acids are reacted with each other in the presence of a catalyst to form nitriles, a portion of which is sold under the trade mark *Arneel* while the bulk is processed further. When hydrogenating a nitrile primary $R.NH_2$, secondary $R_2.NH$ or tertiary $R.R_2'.N$ amines result according to type of catalyst used and operating conditions. All these amines are sold under the trade mark *Armeen*. The amines can also be processed further. For instance, they are made into *Ethomeens*, which are ethylene oxide condensation products of amines. The visitors also saw the plant where the amines are made into their water-soluble forms, *i.e.* their acetate salts—*Armacs*—or their quaternary ammonium salts—*Arquads*. The same plant is also used in the manufacture of a unique range of oil-soluble quaternary salts of the type dialkyl-di-methyl-ammonium chloride. Another interesting range of products are the *Armids*, which are non-ionic amides of fatty acids of the general formula $R.CO.NH_2$, and the *Duomeens*, which are diamines of the formula $R.NH.C_3H_6NH_2$, where R are fatty acid chains. The *Duomeens* themselves are capable of a number of additive and other chemical reactions.



Part of the Littleborough plant with fractionation unit, producing 'Distec' fatty acids in background, and plant producing Armour chemicals in foreground.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Coating protects steel drying towers

The process of manufacturing a soapless detergent powder at the Warrington plant of Joseph Crosfield & Sons Ltd. involves a stage in which constituents of the detergent in the form of a slurry are dried to a powder.

This drying operation is carried out in a steel tower about 100 ft. high and 30 ft. diameter, in which the slurry is spray dried in a current of very hot air. The moisture-laden air from this process, at a temperature of about 100°C., is freed from dust by passage through a dry collector system and is then exhausted from the top of a tower through a final wet scrubbing system. The combination of scrubbing liquor, high temperature and humidity creates conditions at the top of the tower which make the protection of the steel surfaces in the immediate vicinity of the tower discharge a very difficult problem.

Various types of conventional protective paints have been used on this steelwork, but without success. Special protective methods were therefore needed.

After investigation an *Epikote* resin-based system was tried out on the tower. This system incorporates *Anotect*—a one-pack air-drying brushing zinc primer—and two finishing coats of *Flexakote*, which is an amine-cured *Epikote* resin-based paint.

After 18 months' service, this system is still providing excellent protection under difficult process conditions and in the presence of an industrial atmosphere. By comparison, an adjacent tower which has a conventional coating is showing obvious signs of paint breakdown, although in this instance the tower is used for a less arduous duty. **CPE 302**

Heat-resistant conveyor belt

A new type of conveyor belt now being introduced commercially features a cover of *Hypalon* chemical rubber. According to the manufacturers, the new belt, lifting hot salt from a direct-fired rotary drier to storage bins 27 ft. above, has demonstrated outstanding heat resistance by lasting twice as long as the best belting formerly available.

The belt—57-ft. long and equipped with 56 *Monel* metal buckets—operates seven days a week carrying salt through a sheet-metal enclosure which, while it keeps the salt dry, also maintains temperatures ranging from 150 to 260°C.

Belts on this operation previously lasted from two to three months at most. Failure came as the rubber adjacent to the metal buckets became brittle, especially around the rivets used to attach the buckets to the belt. Then the belt broke, tying up the entire production unit.

The new belt, covered with *Hypalon* chemical rubber, lasted more than six months. When the belt finally broke, it is claimed that this was because the carcass failed, rather than the *Hypalon* cover. **CPE 303**

This picture shows the contrast between the coatings on two drying towers after 18 months' exposure. The one on the left was coated with conventional paint while, for the right-hand tower, the coating described in the text was used.

'Plastic steel' for moulding

A special heat-resistant type of 'plastic steel' has been developed for the plastics and rubber industries. The makers state that it is being used for making compression and injection moulds at a previously impossibly low price, in only a few hours of working time. As a result, it is claimed, many articles can now be put quickly into production that, owing to the high costs of moulds, formerly could not be manufactured profitably.

The material requires no special training to use it, being simply poured around a model which may be of wood, plaster of Paris, or practically any other material.

When hard, this new material is similar in many respects to aluminium. It weighs 16 cu. in. to the pound, its heat resistance is good, and it has a compression strength of over 5,000 p.s.i. at 400°F. It suffers practically no shrinkage or distortion during hardening.

It is further stated that, once hard,

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the material will not deteriorate or change. It can be drilled, ground, threaded or machined with regular metal-working tools. The heat transference is not as high as steel, but it is stated that once up to temperature it will hold its heat extremely well. **CPE 304**

Blowers and exhausters

A redesigned range of blowers, boosters and exhausters include, as main alterations, redesigned and improved-type glands with deeper stuffing boxes which are claimed to be absolutely gas tight, and larger-diameter shafts which tend to put the machine beyond the limits of torsional vibration difficulties.

The overall length has been reduced by incorporating the outer bearings in the main headplate and gearbox casting, which also facilitates accurate machining and assembly.

In addition, the cylinder is now bolted on to the baseplate and this, together with the reduced length and larger-diameter shafts, greatly increases the mechanical strength of the machine. **CPE 305**

Mobile crane

A mobile crane, the *Iron Fairy*, is designed to deal with those lifting and shifting jobs where the distance travelled is high in relation to the vertical lift. Loaded it can travel at 5 to 10 m.p.h. and unloaded will reach 30 m.p.h. The makers claim that the equipment makes it eminently suited for road travel, and that the low overall height enables it to pass through a 9-ft.-high doorway, and to operate under a 10-ft. ceiling, where the telescoping jib is useful. In addition, it caters for those jobs where precision in hoisting and lowering is necessary.

One advantage claimed when used for handling lengthy objects such as timber, cast iron or steel plates, is that the load can be slewed round lengthwise beside the driver, enabling the crane and load to pass a doorway 7 ft. 4 in. wide.

For general industrial loading or unloading of lorries where the lift is relatively small the crane is again useful because of its high travelling speed and its ability to negotiate restricted gangways. Its telescoping jib enables the load to be placed in positions impossible for any other machine, so that it can go straight into the stores or machine shop. **CPE 306**

Densified wood laminates overcome filtering problem

A problem which presented itself to the engineering department of Hardman & Holden Ltd. involved the filtering of warm sulphurous oxidising liquor in a sulphur recovery plant. Timber plates had been tried, but they became completely denatured after only a few months' service, owing mainly to the fact that temperatures would often reach boiling point for limited periods. The possibility was therefore discussed of using a densified wood laminate for this application, although, because it is a cellulose-based material, conditions were considered to be particularly arduous.

A trial number of plates were made up, each from one piece of material to eliminate metal rod jointing, so liable to chemical attack on fabricated timber frames. After 12 months' service, these plates and frames proved to be entirely satisfactory. The makers say that the mechanical properties were completely unaffected, so that when a full set was put into service the thickness of the plates could be reduced with a corresponding increase in the frame thickness. This reduced the press shut-down time per day.

There were also additional advantages in the 'cake' washing process, as the hard polished surface of the material resists chemical attack, thus simplifying the task of cleaning out the ports and reeds. Timber can become a mass of spongy fibre and difficult to clean under these conditions.

A complete set of densified laminated wood filter press plates and frames being used to filter warm, sulphurous oxidising liquor.

One of the significant conclusions which has resulted from these lengthy tests, the makers say, is that of economy. Whilst densified wood laminates are four or five times more costly than timber filter press plates and frames, the long-term effect of fewer replacements, easier handling and quicker turn-round are decisive factors in their favour for this type of application. **CPE 307**

Ion exchange development

Continuous electrical ion transfer can be accomplished in solution by the use of a membrane system developed by an American firm.

The distinguishing feature of the ionics system using ion-transfer membranes is that two (or more) process streams are physically separated but electrically connected by the membranes. By passage of electric current, ions are selectively and continuously transferred from stream to stream.

The membranes are large, thin sheets of ion-exchange resin (formerly available only as small beads). Two types are available, one of which conducts electricity by transfer of cations, the other by transfer of anions. The membranes are impermeable to liquid and are chemically stable in acid and alkaline media.

Cation and anion membranes are alternately spaced to separate a series of solution compartments. On passage of current, alternate compartments are diluted and alternate compartments become concentrated in electrolytes. This technique has been used in the treatment of salt-containing water, ash-containing organic solutions, and species of differing ionisation or mobility.

The electrolytic cell consists of stacked membranes, spacers and electrodes with manifold connections for continuous flow of two or more streams. The cell occupies about 3 sq. ft. of floor area and is capable of transferring up to 1 ton/day of salts.

Ionic constituents may be fractionated in multiple membrane units to produce continuous separate fractions of fast-moving from slow-moving ions. **CPE 308**

Oxygen scavenger for industrial boilers

A new, completely non-flammable form of hydrazine for deoxygenation of boiler feedwater that has been introduced in the United States is called *Scav-Ox*, and is a 35% solution of hydrazine in water. It has no flash point and no fire point, yet, it is claimed, it retains all the advantages of hydrazine as an oxygen scavenger and corrosion inhibitor.

Hydrazine has found limited application in boiler feedwater treatment for several years, but handling precautions necessitated by its flammability have confined its use principally to large consumers such as power generating stations. The new non-flammable *Scav-Ox* form eliminates these restrictions and also permits shipment of the material in lighter, easier-to-handle containers.

As *Scav-Ox*, hydrazine can readily be fed continuously to industrial boilers by means of a chemical proportioning pump leading into the feedwater line. The solution is usually introduced at a point between the outlet of the deaerator and the intake of the boiler feedwater storage tank.

CPE 309

Spout flow indicator

A new spout flow indicator, recommended for use with grain and similar free-flowing granular materials, is claimed by its manufacturers to assist in the control of plant from a central point by indicating exactly when material begins or ceases to flow in any given spout.

The indicator is a self-contained unit which can be fitted to any shape and diameter of spout. The operative unit is housed in an aluminium box which is mounted on the spout by an aluminium saddle. The detector itself is a sensitively balanced flap valve inside the spout.

The valve is carried on a spindle revolving on dust-proof bearings inside the saddle. The movement of the valve is transmitted through the spindle to a cam inside the switch box. The movement of the cam actuates a pair of special pivot-arm Burgess switches. The point at which the switches come into and out of operation is set by loosening a locking screw and repositioning the cam.

The unit can be made to light or extinguish indicator, or warning lamps or trigger alarm apparatus, or start and stop motors. **CPE 310**

Hoisting a heat exchanger bundle with a wire belt sling.

Slings for lifting

Wire belt slings are available which can be used for hoisting heavy and awkward loads, including tube bundles, long cylinders and drums, girders, machinery, etc. The standard range of sling uses heavy-duty 10-gauge steel wire fabric suitable for the majority of applications, while for special applications slings of different fabric meshes in a variety of materials are available.

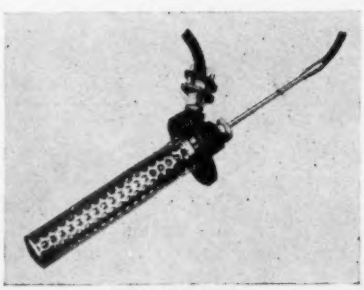
The makers claim that because the sling is fully articulated there is no flexure of the wires used in construction, so that metal fatigue is reduced to a minimum and a long working life is assured. Greater width in the sling gives better load balance and gripping power. It is claimed that there is little danger of a load slipping, even during an off-centre lift, owing to the gripping action of the sling.

It is further stated that the transverse looped wire construction of the belt eliminates kinking or tangling and permits the sling to bend easily around articles of small diameter. The handles are designed for a basket or a choke hitch to be used, whilst the complete sling stores in a compact bundle when not in use.

CPE 311

Humidity measurement

The British makers of a system of dewpoint measurement announce that it can now be supplied with a specially adapted *Dewcel* for use in processes where flame hazards exist. This element has been slightly modified, and is provided with flameproof connections, cable and transformer. As a result the Factory Department of the Ministry of Labour and National Service has granted a Certificate of Intrinsic Safety. The field of application has thus been enlarged and the modified unit may now be used, for example, in gas works, oil refineries or in the presence of hydrocarbon gas. It may also be used where humidity conditions are critical but where inflammable acetone or solvents are evaporated as in cellulose plants or where driers and similar units are used on coated papers, carbon papers, adhesive tape, etc.



'Dewcel' device.

The *Dewcel* consists essentially of

a thermometer bulb inside a thin-walled metal tube covered with a woven-glass tape impregnated with lithium chloride. The tube is wound with a pair of silver or gold wires over the tape and covered with a perforated metal guard. When the lithium chloride salt absorbs moisture from the surrounding atmosphere it becomes an electrical conductor, so that current passes between the two wires, thus raising the temperature of the unit until equilibrium is reached. This equilibrium temperature is measured with a conventional temperature bulb, either liquid expansion or electrical resistance thermometer type, and is then converted by the instrument to record, in dewpoint temperatures, grains of moisture/lb. of dry air, grains of moisture/cu.ft. or percentage of water by volume.

The complete system comprises the *Dewcel*, a power unit and either a liquid expansion type recorder or a dynalog recorder. In each case the system may be furnished with control mechanism for the automatic control of valves, dampers, motors, etc.

CPE 312

Wall chart plots processes, etc.

A new *Movigraph* wall chart is claimed to make it possible to build up a picture of practically every state, process or operation known to industry and commerce, and to give instantly a graphic appraisal of any position at a given moment.

The plastics panel which is the basis of the system has 2,000 perforations/sq.ft. Panels come in various sizes, the smallest being 23 in. × 11½ in. They will butt together to form an installation of any given size.

There are six major signals, each in 12 colours, giving over 20,000 signalling combinations. Signals simply peg in the board, are easily removed but cannot be accidentally dislodged. Special signals indicate various things —for example, ring markers to show completed jobs. Figures and letters are available in various sizes and colours. Title frames, supplied for easy identification, will carry card strips bearing typewritten or handwritten data.

To chart the progress of any process, operation or activity, the chart is fitted with flow lines. Each of these consists of a length of distinctively coloured elasticated cord, pulled across the chart and kept in position by a peg. They return to starting position when not in use. Flow lines can be attached and removed by inexperienced hands.

An optional extra is a card index panel, containing 80 6-in. × 4-in. cards, each coinciding with a line of perforations on a panel. One index panel can be placed above another to allow for expanding requirements.

Where a card index is not required, an index holder, 3-in. long, can be inserted on a panel at any position, according to the amount of information to be accommodated. Each holder will carry up to 11 index strips, but can be shortened. Each panel is provided with hooks for hanging on a wall. Rubber studs prevent the back of the chart from rubbing against the wall.

Price of the *Movigraph* varies with the type and size of chart required. A small installation can be obtained for £6. **CPE 313**

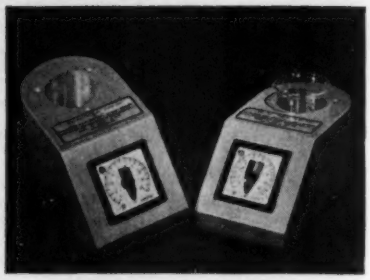
FLAME HARDENING OF PIPES COMBATS MINING SUBSIDENCE

The use of a special process to combat mining subsidence has recently been approved by the National Coal Board.

To remove the danger of subsidence of the surface near coal fields, some means of support must be provided within underground workings. In areas which are of no further use, the workings are usually filled in with pit spoilage which is crushed, mixed into a slurry with water, and forced by compressed air through steel pipes into the workings.

The aggregate forms into a concrete-like mass and is able to withstand a great amount of pressure. But, owing to the extremely abrasive nature of the aggregate, the bore of the stowing pipe is subjected to a considerable amount of wear and the process becomes uneconomical.

With a view to lengthening the life of the pipes, a British firm have been experimenting on the internal hardening of a number of pipes by the use of their flame hardening process. The pipes have been subjected to field tests over a considerable period, and the results are stated to have proved very satisfactory. **CPE 314**



HEATING JACKET FOR GLASSWARE

A heater to suit a standard glass beaker, which has recently come on the market, incorporates an energy regulator for controlling the heat input. It also has a steel sheath protecting the element against possible breakage of the beaker and damage from the contents. The makers claim that the main advantage of this apparatus over the standard type of beaker mantle is this protection that is afforded to the element, coupled with the fact that should the beaker break the operator would save the contents.

The same firm also makes a wide range of heating mantles and control gear. **CPE 315**

Laboratory breaker

A useful breaker for laboratory testing purposes is a hand-operated machine designed on similar lines to bigger, power-driven types. The makers claim that it easily proves the breaking characteristics of different materials and sells for less than £150.

CPE 316

Fire-resistant slates

Asbestos-based, square-butt, flexible strip slates are now being produced for buildings where a high degree of fire resistance is required.

The new slate has a base of bitumen-impregnated asbestos fibres. The slates are supplied in strips of two and it is claimed that they are completely weather resisting and that, once in position, they cannot slip or crack. The flexible and bituminous nature of the slates also obviates the possibility of damage in transit or laying.

A substantial layer of grey mineral granules is applied under pressure to the surface of the slates during manufacture to give not only colour and rough texture but also to increase reflectivity and thus lengthen the life of the roofing.

Sufficient asbestos-based slates for 100 sq. ft. of roof surface cost 110s.

CPE 317

Instrument repair

The repair, reconditioning and recalibration of all types and makes of electrical indicating and measuring instruments and photographic exposure meters are undertaken by a London company.

They are handling work ranging from miniature industrial switchboard meters to precision-grade portable and bench-type laboratory instruments, and are offering a normal delivery of 14 to 21 days, with a special telephone quotation service if required. **CPE 318**

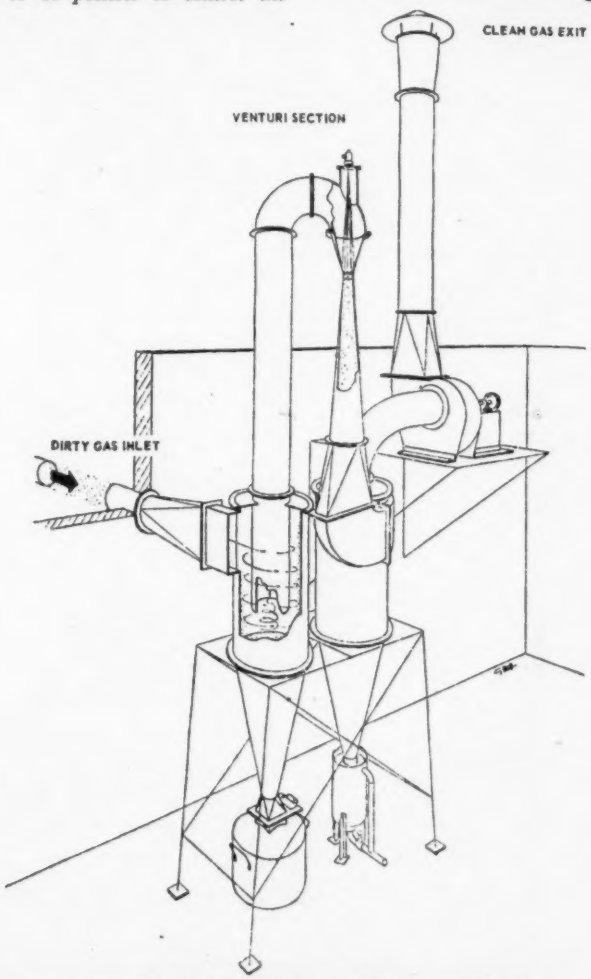
Sieve-testing machine

On show at a recent exhibition was a special machine for sieve testing designed by a British firm. This machine not only projects an enlargement of the sieve mesh on a ground-glass screen, but also automatically calculates the mesh. **CPE 319**

WET VENTURI SCRUBBER

A wet Venturi scrubber for the treatment of air and gases has recently been introduced. The method of operation is particularly noteworthy in that the liquid mist for scrubbing is generated in a separate controlled manner from the main gas stream. By this method it is claimed to be possible to control the particle size of the mist to correspond with that in the gas stream to be treated.

This device is already in use, particularly as a dust collector and a gas washer. The makers state that it has a particularly low pressure drop. **CPE 320**



Layout of typical Venturi scrubber installation.

Dry colouring of styron polystyrene

Dry colouring of polystyrene is a method which enables moulders to produce their own coloured moulding materials by a simple dry mixing technique.

Essentially the process entails tumbling specially prepared polystyrene granules with dyes and pigments so that each particle of polystyrene is evenly coated. The coloured powder is then ready for immediate use in the injection machine, where the final absorption and dispersion of the colour by the polystyrene is completed.

This technique is claimed to have important advantages, including the following:

(*a*) It reduces the necessity for moulders to hold large stocks of coloured moulding powders.
(*b*) No elaborate or expensive equipment is necessary.
(*c*) Any shade of colour can be very easily reproduced at short notice.
(*d*) There is no intermediate step of hot compounding with the accompanying risk of heat degradation of the colour.

Styron 666 colourant crystal has been specially developed for use by this technique. It is supplied in the form of very small uniform pellets approximately $\frac{1}{16}$ in. in diameter.

Styron 475 high-impact colourant blend has also been developed for the dry colouring process for applications requiring increased toughness. Similar techniques are used as for the colourant crystal, but, owing to the colour of the natural material, it is not possible to produce transparent shades, and different dye formulations are required. **CPE 321**

New U.S. furnace cement

A new aluminium oxide cement, developed in the U.S., is said to provide a more heat-resistant, long-lasting lining for indirect-arc-type electric furnaces.

The aluminium oxide, it is claimed, stands up much better to high temperatures and slag attacks than the mullite-base cements commonly used in these furnaces for melting ferrous and non-ferrous alloys. Known as *Kellundite No.* 8, the new material, which can also be used for patching existing furnace linings, is one of several cements developed by the company for furnaces in steel and brass foundries. **CPE 322**

Periscopes for plant inspection

Periscopes are available for use in industrial installations where normal visual examination of objects or phenomena is impossible, due either to their situation or attendant dangers. They are normally installed as part of the plant and equipment, as opposed to *Bodson* endoscopes, made by the same company, which are portable instruments for internal viewing.

The uses of periscopes include examination of workings of dangerous chemical plant (including explosive processing), boiler water level gauge viewing, observation of models in wind tunnels, visual observation of aircraft controls in test flying, etc.

In addition to the above applications, one of the most common is observation inside atomic reactors and in radioactive processing plants; in these cases *Bodson* periscopes can be made entirely of stainless steel and with cerium stabilised radiation-resistant glass lenses.

The normal diameter of *Bodson* periscopes is approximately 1 ft. 2 in. and maximum total length approximately 25 ft., and a variety of bends can be introduced as shown in the enclosed photographs. The field of view if normally 45 to 50°, but magnifications up to eight times are possible if the angle of view is reduced to 60°.

CPE 323

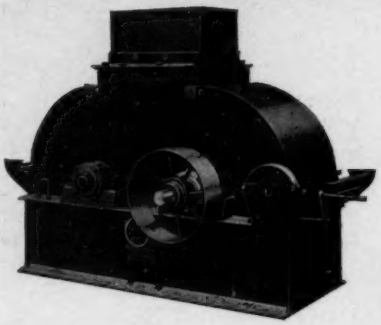
Hydraulic draw bending machines

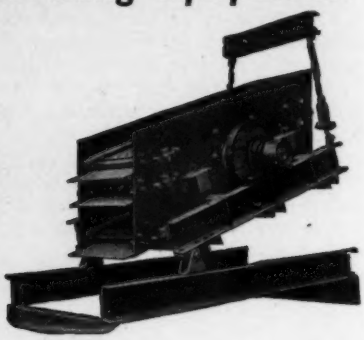
A British firm have recently enlarged their range of tube-bending machinery by the introduction of a series of hydraulic draw benders, in seven sizes, suitable for bending steam pipe and other tubes and sections, in all sizes from 1 in. up to 12 in. bore. The machines are similar in most respects throughout the range.

Among the more interesting features are an indicator which allows the angle of bend to be predetermined by setting a pointer against a dial; an arrangement of mandrel and booster rams, both concentric with the mandrel rod; hydraulic clamping of the tube to the centre former, obviating the necessity for a revolving arm or any other projection beyond the outside of the tube; the building-up of centre formers in malleable iron segments, which is both quick and cheap in manufacture; and arranging the height of each machine so that the work is at bench level.

CPE 324

New crushing and screening equipment





A double-rotor impact breaker, the *Dualpact*, employs two inwards-turning rotary hammer assemblies; these deflect the machine's divided feed into two opposing streams, thus breaking particle against particle. This is quite different from the conventional idea of breaking particles against manganese plates, and the makers claim a saving in replacement parts and costs. This breaker can be used as a form of pulveriser. **CPE 325**

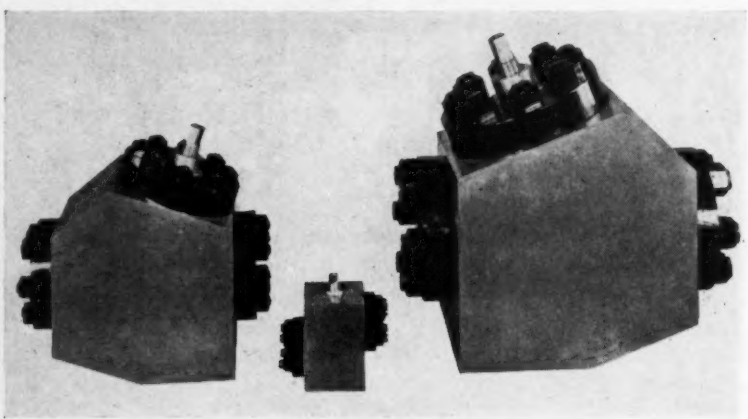
Rota-Vibra grading and vibratory screens are built in single- and multi-deck types over a wide range of sizes. The *Vibra* screen is 18 ft. long. A recent introduction has been the addition of a transformer-type heating equipment which, even on damp clinging sands and similar materials, is said to ensure about the same output and grading efficiency as if the materials were nearer to a dry condition. **CPE 326**

Balanced stop valves

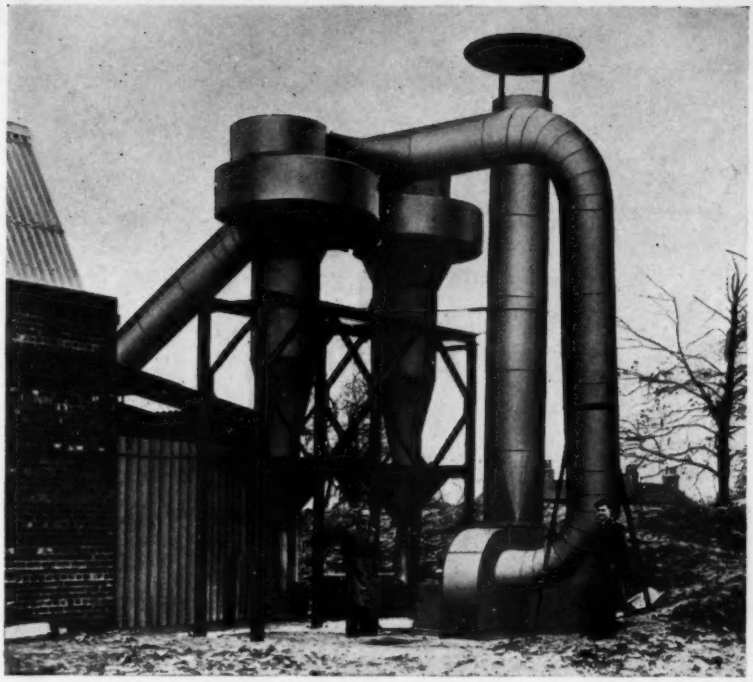
A range of balanced stop valves is offered by a British company who offer the following explanation of their design.

Most simple stop valves in the smaller sizes and at the lower pressures which are directly hand operated through a lever or hand wheel are not difficult to open or close, and the manual effort is small because the mechanical advantage of the lever or the hand wheel and screw is easily sufficient to overcome the opposing load set up by the fluid under pressure. However, if the size is increased and/or the pressures are increased, there is difficulty in operating a simple valve and the length of the lever or hand wheel would become enormous in relation to the size of the valve itself.

One method of overcoming this is to balance as far as is practicable the load on the spindle which seats on the valve, and this is usually done by having a larger area above the valve on the lever or hand wheel side, so that the fluid exerts the load on this larger area, helping to balance out the load on the spindle and leaving a rela-



Balanced stop valves.



'Cyclol' dust collector installation.

tively small manual effort to be applied to the lever or hand wheel to operate the valve.

Another method of alleviating the load on the valve spindle is to fit a small pilot valve which can be opened easily by hand just in advance of the main valve and so allow pressure to be applied to the underside of the valve seat and relieve the load on the valve spindle which can then be easily operated.

The manufacturers have compiled a list of stop valves showing the sizes of valves which should be of the balanced or alternatively pilot-operated type according to the working pressures.

Hydraulic stop valves can, of course, be operated electrically through a solenoid or thruster or perhaps by a solenoid-operated pilot valve, especially in cases of remote control.

CPE 327

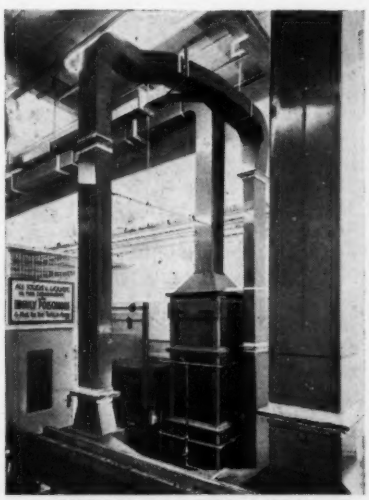
Acid fume extraction plant in rigid PVC

One of the largest rigid PVC installations in Britain has just been completed in the plating and polishing departments at the Blackburn factory of Mullards Ltd.

Perhaps the most impressive section of the new equipment is the elaborate network of rigid PVC ducting which removes the corrosive fumes given off during the silver-plating process.

Ducting and absorption towers in rigid PVC are also employed in the electrolytic polishing department.

The manufacturers of this PVC claim that it was selected as the material of construction because of its outstanding resistance to acid attack, its lightness in weight and the ease with which it is fabricated by hot-air welding. **CPE 328**



PVC fume extraction plant.

New dust collector

A dust collector is now available which is claimed to have operating efficiency of 100% on any particles larger than 30 microns or 80% on 12-micron size (1 micron = 1/25,400th part of 1 in.).

A feature is that the fan can generally be mounted on the cleaned air side, thus obviating wear on the fan blade and fan scroll.

The *Cyclol*, as this dust collector is called, is claimed to be very versatile, and it is stated that it is particularly useful where heavy loadings of the finer dusts occur. The unit has a further application in that installation is possible as a pre-cleaner to clean air before passing to a cloth filter, thus obviating wear on the filter and reducing the amount of cleaning necessary. **CPE 329**

New cleaning process for metals

An American process for cleaning iron and steel castings, stripping paint, removing rust, grease, etc., is now available in Britain. It consists of an electrically activated, catalysed, molten oxidation or reduction bath used to give castings a metallurgically clean surface. Chemically the cleaning agent used is a hygroscopic alkali base containing neutral salts which act catalytically when activated electrically. It is used as a fused salt and the salts are completely water-soluble.

The chemical reactions in the bath are produced and controlled electrically. The electrical energy for activating the bath can be supplied by a 6- to 8-volt d.c. source of suitable amperage for the size and volume of work to be processed.

One lead from the d.c. source is connected to the tank which contains the salt bath. The other lead is connected to the work basket or fixture which is immersed in the salt bath. This makes the work cathodic (negative), and so reducing members are formed in the bath at the surface of the work. Thus sand, scale, rust and other oxides are removed. The surface is then metallurgically clean.

The equipment required in cleaning castings is housed in a single unit which consists of a *Kolene* tank, a cold rinse tank, a hot-water rinse tank and an adequately ventilated hood. The *Kolene* tank is heated by any suitable means—gas or electricity—and is also supplied with a means of supplying direct current to the bath.

The d.c. requirements for this equipment are supplied by suitable rectifiers; the rinse tanks are self-explanatory and are used with ordinary mains water.

The process is stated to be adaptable to every type of operation, large or small, and the unit can be set up as a separate operation, or can be incorporated as a part of an automation system. In the United States, units have been designed with special conveyor installations, some of which are handling 6 tons/hr. of castings completely automatically. Even with units of the small 'batch type,' it is possible to process up to 500 lb./hr. of castings; the work is brought to this size of unit as a rule rather than 'conveyorising' it.

The process is also used extensively for the preparing of bearing backs prior to white metalling. Similar principles also apply to silver soldering as with tinning or white metalling. When the process is used solely for cleaning, the reduction cycle (work negative) is used. To prepare work prior to tinning, the oxidation cycle (work positive) is used.

In general, the reduction cycle is used for the removal of scales (mill, forging and heat treatment), rust, oxides and sand inclusions. The oxidation cycle is used for the removal of oils, greases, organic materials, sulphur, phosphorus, manganese, graphite and carbon. The makers say that it is a simple matter to change from the one cycle to the other by means of a change-over switch, which is operated while the work is still in the salt bath. **CPE 330**

Monitor sieve for crushing

A monitor sieve which is manufactured from 26 S.W.G. bright polished brass consists of easily assembled units, comprising four sieve trays with meshes suitable for a particular range of applications, together with a pan size $2\frac{3}{4}$-in. diameter and a lid $3\frac{3}{8}$-in. diameter. The overall size when collapsed is $1\frac{1}{4}$-in. deep $\times$ $4\frac{1}{16}$-in. diameter. Thus, in its collapsed but readily assembled form, the sieve may be easily carried in the pocket, ready for immediate use. The four sieve meshes included in the assembly may be of B.S., or A.S.T.M., or commercial quality and, unless otherwise specified, the coarsest mesh is supplied in the top sieve, with progressive reduction to the finest in the bottom member. **CPE 331**

CONTROL DESK FOR A SHIFT MANAGER

A new control desk has been made for Imperial Chemical Industries' plant at Billingham. It is a shift manager's desk and is designed to focus at one point the critical measurements which the shift manager requires to have under his eye at all times.

In the centre of the panel, over the desk proper, three Consotrol *two-pen recorders provide a continuous record of six critical measurements. The small amount of space taken up by these* Consotrol *recorders is well illustrated in this application, where they are so grouped that the six records can be comfortably seen with a single glance.*

On the left of the desk is an F/M radio receiver which provides up-to-the-minute weather forecasts. Weather conditions may have an important bearing on the operation of plants which use large amounts of cooling water or are affected by extreme changes of temperature. **CPE 332**

Furoic acid

Furoic acid, now being manufactured in Britain in commercial quantities, may be said to have properties falling into three groups. Primarily it is an organic acid and has all the usual properties of such an acid. It can readily be converted into the acid chloride, amide, substituted amides and a whole range of esters.

Associated with the aromatic-type furan ring are a series of secondary properties including substitutions. Furoic acid may be nitrated and sulphonated directly, giving 5-nitro and 5 sulpho-furoic acid, respectively, although a certain amount of care must be exercised to avoid replacing the carboxyl group or splitting the ring. Protection of the carboxyl group by esterification, although not strictly necessary, makes it easier to avoid side reactions.

Other aromatic-type reactions which may be carried out on the acid or its esters include those of the Friedel-Crafts type producing useful alkyl or acyl derivatives, substitution occurring in the -5 position. Chloromethylation may also be carried out to yield 5 chloromethyl furoic acid and, under other conditions, certain other compounds.

Finally, a series of reactions more specific to the furan ring are encountered. These are generally largely suppressed by the carboxyl group. The ring is very much more stable than usual, only extreme acid or oxidising conditions affecting it, and addition reactions not being of great importance.

However, if the reaction conditions and procedure are correctly selected, all the potentialities of the furan ring may be realised and a series of cyclic or straight-chain compounds may be prepared, with substituents in various positions if desired. **CPE 333**

★ Personal Paragraphs ★

★ **Dr. T. Kennedy** has been appointed personal assistant to Mr. A. C. H. Cairns, chemical sales director of Joseph Crosfield & Sons Ltd. Dr. Kennedy's former post as manager of Crosfield's technical service department, the activities and scope of which have grown very considerably during his seven years' control, has been taken by **Mr. J. G. Walker.**

★ **Mr. D. V. Parker,** formerly of Matthew Hall & Co. Ltd. and Alfa Laval, has now joined Heat Transfer Ltd. as chief designer.

★ **Mr. H. W. G. Hignett** has been appointed assistant managing director of Henry Wiggin & Co. Ltd. He is a director of the company and was responsible for technical (metallurgical) control and development in all Wiggin plants. He was previously superintendent of the Mond Nickel Co.'s Birmingham research laboratory.

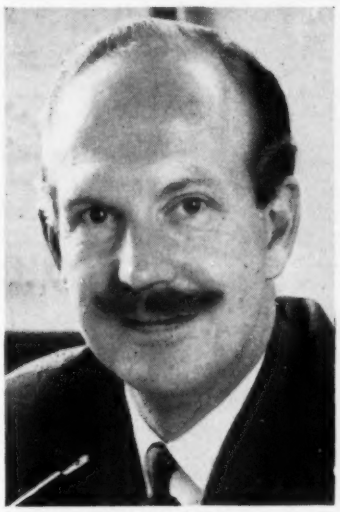
★ **Mr. A. W. Morrison** has joined Expandite Ltd. as technical manager responsible for production and development. He has had a wide experience in the chemical and chemical engineering industries, and has also been associated with Government research, having been secretary of the Cremer Committee on Chemical Engineering Research in Great Britain.

★ **Mr. R. Gillespie,** C.B.E., on appointment to the board of the British Petroleum Co., has ceased to be managing director of the B.P. Tanker Co., although he remains a director of the latter company. **Mr. J. Houston Jackson,** general manager of the B.P. Tanker Co., has been appointed a director. He retains the general managership. **Mr. D. G. L. Bean** has been appointed deputy general manager, having been transferred to the B.P. Tanker Co. from B.P. Trading Ltd.

Dr. T. Kennedy.

★ **Mr. M. F. Lindsley, Jun.,** has been named director of production for the Explosives Division of Olin Mathieson Chemical Corporation, U.S. He was formerly assistant to the president in charge of production of the King Powder Co., Cincinnati, and had been with the company 28 years before joining Olin Mathieson.

★ **Mr. B. H. Wilcoxon** has been appointed manager of operations of the Insecticide Division of Olin Mathieson Chemical Corporation, U.S. He was vice-president and general manager of the Calabama Chemical Co. before its acquisition by Olin Mathieson and for the past 18 months he has continued to serve as manager of the former Calabama plants.



Mr. J. G. Walker.

★ The Council of the Royal Society of Arts has awarded its Bicentenary Medal for 1956 to **Dr. W. J. Worboys,** chairman of the Council of Industrial Design, for his outstanding services to the promotion of industrial design, particularly in connection with the establishment of the Design Centre, which was opened by the Duke of Edinburgh in April of this year. Dr. Worboys is a director of Imperial Chemical Industries Ltd., vice-president of the Association of British Chemical Manufacturers, and a member of the Council of the Society of Chemical Industry.

★ **Mr. A. Coates,** chief buyer of Thames Board Mills Ltd., has recently retired on medical advice. He is continuing to serve Thames Board Mills Ltd. in a consultative capacity, however.

Seen here at the luncheon which marked the opening of Hess Products' new plant, described on another page, are, left to right: Mr. T. D. Lively, Mr. S. R. H. Fletcher (chairman of Hess Products Ltd.), Mr. J. M. Hoerner, Mr. J. T. Barrie and Mr. R. H. Potts.

World News

INDIA

New sulphuric acid plant

Fertilisers & Chemicals, Travancore, Ltd., have signed a contract with Chemiebau Dr. A. Zieren GmbH. for the construction of a new sulphuric acid contact plant. This plant will utilise elemental sulphur for the production of 160 tons/day of monohydrate.

The new plant, together with two existing units, makes F.A.C.T. the largest manufacturer of sulphuric acid in India. The acid will be used partly for increasing their production of ammonium sulphate and also for a new ammonium phosphate plant which forms parts of a major development scheme. This information has been given out by the Power-Gas Corporation Ltd., Stockton-on-Tees, England, (through whom the Chemiebau Zieren design of sulphuric acid plant is available in the United Kingdom).

Aluminium plant

The proposed 10,000-ton aluminium plant provided for under the Indian Second Five-Year Plan at a cost of 100 million rupees will probably be erected at Mettur in the Salem District of West Madras. The Indian Minister of Commerce and Industries has stated that, as a result of negotiations with the Madras Government, a 60-acre plot had been allocated for the plant and sufficient power would be available.

The construction of the plant, he added, would depend upon the availability of good-quality bauxite in the area.

NIGERIA

Plastics factory planned

An agreement was signed in Rome recently between the Western Region Production Development Board and two United Kingdom firms, under which a plastics factory is to be established in the western region. Initial production will be restricted to plastic piping, conduits, etc., but eventually a wide range of plastic products will be manufactured including such articles as combs, beakers, cups, lampshades, casings for telephones, raincoats, etc.

NORWAY

Niobium

At Söve, in Telemark, Europe's only niobium mine is being extended. Up to now the niobium has been exported as concentrate. From next year it will be processed at Söve into ferroniobium. Niobium is very rare and is much in demand, as it can withstand exceptionally high temperatures—for instance, in jet engines. Last year at Söve, 400 tons of concentrate were produced from 100,000 tons of ore. The concentrate was sold for £350,000. The Söve plant is owned by the State mining corporation.

Aluminium

An aluminium plant will be built at Mosjoen by Elektro Kjemisk A/S. at a cost of some Kr.150 million, and the initial production of aluminium is expected to be 20,000 tons p.a., to start in 1958-59.

SOUTH AFRICA

New oil and grease plants

Shell's plans for a new lubricating-oil blending plant in Durban have been approved, and work is now in progress. It has also been decided to install a modern grease plant at Durban to manufacture all the company's grease requirements in the Union and neighbouring territories. The total cost of these two plants will be about £1 million and it is hoped that the lubricating-oil blending plant will be finished by the end of 1956.

When these plants are finished, the company will have facilities for making about 150 different grades of oils and 80 different grades of grease, and it will save the Union over £1 million yearly in foreign exchange previously spent on products and containers.

Mineral production in Africa

A review published by the United Nations recently declares that mineral production in Africa was at a higher level in 1954 than in 1953 and continued to increase in the first half of 1955, mainly due to the higher export demand arising from increased industrial activities in Europe and North America.

Significant increases in 1954 were recorded in the output of antimony, bauxite, cobalt, copper, gold, lead, nickel, tungsten and phosphate rock; production of iron ore, tin and zinc declined.

Output of uranium in the Union of South Africa rose sharply in 1954 and continued to rise in 1955—profits from uranium mining went from £1.8 million in 1953 to £8.1 million in 1954. By July 1955 there were 26 mining companies providing ores and slimes for treatment in the eight extracting plants which were to be added in 1955.

NETHERLANDS

Alkali project

N.V. Koninklijke Nederlandsche Zoutindustrie has acquired the rights to exploit the rich salt deposits near Winschoten in the province of Groningen. By way of 20 km. of pipeline between Winschoten and the sea port of Delfzijl, Zoutindustrie will deliver a saturated brine for the soda plant to be erected at Delfzijl. This plant will have an initial capacity of 150,000 tons p.a.

At present Zoutindustrie is one of the largest manufacturers of sodium chloride in Europe. Mercury cells of their own design are installed in the electrolysis plant at Hengelo. Next to the soda plant at Delfzijl they will build a new caustic soda/chlorine plant. It has been decided that de Nora amalgam cells will be employed. Cells of the de Nora 14 T.G.L. type, which can operate up to 50,000 amp., will be installed and the initial capacity of the plant will be approximately 60 tons/day of chlorine.

PERU

New pipeline

The Compania de Petroleo Ganso Azul Ltda. recently opened its pipeline from Aguas Calientes to Pucallpa. Revised figures show the capacity of the pipeline as 4,500 bbl./day, although only 2,000 barrels are being piped at present. The crude oil will be transported in barges from Pucallpa to the refinery of the Empresa Petrolera Fiscal in Iquitos. Some may also be exported to Manaos. The improved transport facilities as a result of the pipeline will enable the company to step up its output of crude.

Metallurgical projects

The semi-official Banco Minero, which lends financial assistance to the mining industry, is to set up a lead refinery in Peru.

The Southern Peru Copper Corporation recently announced that the contract for the opening up of the copper mines at and near Toquepala had been awarded to two U.S. firms with the approval of the U.S. Export-Import Bank, who are lending $100 million for the project. The contract is believed to be worth $80 million.

The Cerro de Pasco Corporation will shortly be opening a new hydroelectric plant of 85,000-kw. capacity on the Paucartambo River, near Carhuamayo, in the southern highlands, to supply power to their zinc refinery there, the output of which could then be stepped up to 110 tons of pure zinc bars daily.

AUSTRALIA

Fellowship in Chemical Engineering

A Fellowship in Chemical Engineering, worth £A1,000, is being offered by the British Memorial Fund, established in Victoria, Australia, by public subscription. The Fellowship is a gesture of 'loyalty, gratitude and affection' to the British people in recognition of their 'role in saving civilisation in the second world war.' It provides for 10 months' study in Victoria for the selected candidate and covers travelling and living expenses during the period.

The Fellowship is open to workers in any aspect of chemical engineering research or chemical engineering education who could benefit by their participation in the development of this science in Australia.

Full details can be obtained from Col. the Hon. W. W. Leggatt, Agent-General for Victoria and Chairman of the British Memorial Fund, London Selection Committee, Victoria House, Melbourne Place, Strand, London, W.C.2. Closing date for the receipt of applications is September 15, 1956.

FRANCE

Chemical and chemical engineering conferences

The Convention of Chemical Sciences, 1956, will take place in Paris from November 18 to December 3 next, at the same time as the 4th Salon de la Chimie—Caoutchouc-Matières Plastiques.

This will include several meetings of particular importance, notably the 29th International Congress of Industrial Chemistry, the 1st European Congress of Corrosion, the European Conference of Chemical Engineering and the Paris Technical Meetings.

The European Conference of Chemical Engineering will include three symposiums on the following subjects: calculations of converters, calculations of reactors and extraction by solid adsorbents.

GREECE

Nitrate plant

A nitrate fertiliser factory is to be built at Ptolemais, west Macedonia. The output of the factory will amount to 70,000 tons p.a., which would be sufficient to meet the country's requirements.

As we go to press, international tenders are expected to be called for shortly, while the Koppers Co., U.S., has already submitted a study on the design of the project to the Greek Government.

SWITZERLAND

Chemical plant for Brazil

It is announced in Berne that three Swiss chemical companies—Sandoz, Ciba and Geigy—have agreed jointly to establish a plant in the Resende district of the state of Rio de Janeiro.

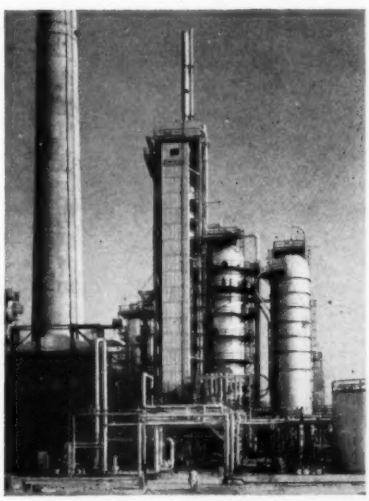
Construction will begin next year and production will start in 1959 with an initial estimated annual capacity of 300 tons of aniline and 150 tons of basic chemicals for the pharmaceutical and tanning industries.

ISRAEL

Potash production at Sdom to reach 135,000 tons p.a.

An American expert at Sdom has expressed the conviction that it will be possible to reach an annual output of 135,000 tons of potash, the Minister of Development announced recently. The Minister revealed that a sum of about £I29 million had been sunk into the potash works. He said that a special committee would be appointed shortly to study the exact nature of the investments in the potash enterprise at the Dead Sea.

At the same time as the Minister of Development's announcement, it was revealed that the current expenses involved in the running of the plant's equipment total £I350,000/month. At the present the enterprise produces about 3,000 tons/month of potash and its sale amounts to about £I150,000 (*i.e.* £I50/ton). The current loss amounted to about £I200,000/month.



A picture taken at Britain's Fawley oil refinery recently. As reported on page 259, Esso Petroleum Co. Ltd. are to spend a further £13 million on expansion plans there. This picture shows the £4-million catalytic 'Hydroformer' recently brought into operation.

BULGARIA

Manganese and iron deposits

Large industrial deposits of manganese ores have been found near Kalimantsi village, Stalin district, in the eastern part of Bulgaria.

Bulldozers, scrapers and excavators are preparing the site for exploitation. It is planned to build a large ore-dressing plant nearby.

A report on the iron-ore deposits near Kremikovtsi, Sofia district, which have been extensively surveyed since 1953, shows that the deposits far surpass the most optimistic estimates previously made and will provide abundant supplies of ore for a large metallurgical centre with blast furnaces, engaging several thousand workers. Plans for the construction of mines and for the development of the area are well in hand.

GREAT BRITAIN

New I.C.I. extensions

Imperial Chemical Industries Ltd. have decided to erect a third oil-cracking plant at their Wilton works in north Yorkshire. Wilton's first oil cracker came into operation in 1951 and the second will come on stream towards the end of this year. The new plant, which will be larger than the others, is scheduled to be ready early in 1959. The main product of the new plant—ethylene—will be used to manufacture *Alkathene*, the I.C.I. brand of polythene; additional plant will be built to raise the company's U.K. capacity for producing *Alkathene* to over 90,000 tons p.a. These extentions, together with ancillary services, will cost over £16 million.

New Chair of Chemical Engineering for Scotland

A new Chair of Chemical Engineering has been created by the Royal Technical College, Glasgow. Dr. A. W. Scott, at present associate professor in the department and a well-known figure in Scottish chemical engineering circles, has been appointed to the new Chair.

Refinery gas re-forming at Romford

The North Thames Gas Board has awarded a contract to Humphreys & Glasgow Ltd. for the installation of four refinery gas re-forming plants at Romford, in Essex.

The purpose of the new plant is to convert refinery gas into town gas of normal calorific value and characteristics which will be fed into the Board's grid. The total installed capacity, including 'standby,' will be approximately 36 million cu.ft./day

of town gas. A ten-year agreement between the Board and Shell provides for the supply of 25 million therms p.a. of refinery gas from the Shell Haven refinery on the Thames estuary.

The plants to be installed by Humphreys & Glasgow will be of the self-steaming type, using the *Onia-Gegi* catalytic conversion process. The installation has been designed to handle the daily supply of refinery gas in any three of the four sections of plant. Under peak load conditions the fourth set can be brought into operation with additional refinery gas or other refinery products.

The plant will be erected in the open with buildings to house the controls, machinery and boosters. The contract includes all civil engineering work and ancillary plant.

Amalgamation proposal

Albright & Wilson Ltd. have announced the signing of a preliminary letter of intent which sets out the basis of negotiations for a proposed amalgamation of their American subsidiary, Oldbury Electro-Chemical Co., with Hooker Electrochemical Co., both of Niagara Falls, N.Y.

Oldbury Electro-Chemical Co., founded by Albright & Wilson in 1896, was the first company to manufacture phosphorus in the U.S. on a commercial scale. It is one of the main producers of sodium chlorate.

'Platformer' in operation at Shell Haven

The second 'platforming' unit built for Shell in the U.K. is now in operation at Shell Haven refinery, Essex. The first unit of this type ever to be erected in this country came on stream at the company's Stanlow refinery, Cheshire, in December 1953.

Erected at a cost of approximately £2½ million, the Shell Haven unit will produce a high-octane component for blending into motor spirit. A 'platformer' is so called because it uses a platinum catalyst to reform low-grade spirit into high-grade spirit.

The introduction of this new unit marks a further stage in the post-war expansion programme in which Shell's refining capacity in the U.K. has expanded from 1 million tons to over 11 million tons p.a.

SPAIN

Furnace for cinnabar distillation

The Spanish Direccion General de Minas has authorised the installation of a third cinnabar distillation furnace at the quicksilver plant in Castaras, Granada Province. The new furnace will be of domestic design and construction, as are the existing units.

UNITED STATES

Polythene production expanding

Two more large companies have announced expansion of production of low-pressure polythene—while an oil company has added its technological know-how to the field.

Union Carbide & Carbon Corporation plans to build two plants to produce low-pressure polythene with a combined capacity of 55 million lb. The new facilities—one at Institute, West Virginia, and the other at Seadrift, Texas—will be equipped to use a number of new techniques. They will employ not only the Ziegler and Phillips Petroleum low-pressure processes under which Carbide is licensed, but also new methods developed in Carbide's own laboratories.

Texas Eastman Co., a division of Eastman Kodak Co., plans construction of a semi-commercial unit at Longview, Texas, to make high-density low-pressure polythene. The unit will be modest in size and will be used for experimental production which may result in eventual commercialisation of a process developed by Standard Oil Co., of Indiana, and licensed to Eastman.

Standard of Indiana claims the advantage of continuous operation for its process and said that the catalyst does not need regeneration. Being granular, it can be filtered out of the product and so give polythene a low ash content.

The licence to Eastman is non-exclusive, but, for the present, Standard of Indiana does not expect to embark on a general licensing programme for the new process.

Powder metallurgy research

A new brass powder has been developed by metallurgists of the New Jersey Zinc Co. in collaboration with the Armour Research Foundation at the Illinois Institute of Technology.

The project is designed to find an alloy hard enough for barrel finishing —that could compete in hardness and strength with wrought metal products —and to obtain a high degree of hardness in new fields of application for powder metallurgy. Several alloys that satisfy these requirements very well have been found, it was stated.

U.S. firm to build U.K. synthetic rubber plant

The Blaw-Knox Co. has announced that it will design and build Great Britain's first synthetic rubber plant near Fawley, Hants. The $12-million contract was awarded to Blaw-Knox by the International Synthetic Rubber Co. (formed by Dunlop Rubber, Michelin Tyre and two British subsidiaries of the American companies, Goodyear and Firestone).

The plant will have a capacity of 50,000 long tons p.a.

Molybdenum-base alloys

A six-year search for a series of molybdenum-base alloys with greater structural strength at high temperatures than existing commercial materials has been successfully completed, Climax-Molybdenum Co. reports. Four alloys will be made available commercially that could be fabricated on normal tool-steel mill equipment. Industrial interest seems likely to centre in their use for die-casting dies, electrodes for glass-melting furnaces and in the manufacture of seamless tubing. The new alloys, as well as pure molybdenum, are made by a process developed by Climax.

The Leonard Hill Technical Group—August

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—A Critical Survey of Automatic Titrators, 1; Surface-Active Agents in Germicides; Some Recent Progress in our Knowledge of Cystine; Cosmetic Engineering, 3; Progress Reports — Therapeutics; Disinfectants and Disinfection; Hormones.

Paint Manufacture — Synthetic Organic Pigments; Amino Coating Resins, 1; Increasing Research Efficiency, 3; Aircraft, Marine and Industrial Finishes; The Use of Styrenated Alkyds.

Building Materials—Floor Finishes for Light Industry; Floor Maintenance.

Corrosion Technology—The Flame Spraying of Metals and Plastics; A Superficial Glance at the Field of Corrosion; The Intercrystallite Corrosion of Stainless Steels—A Soviet Symposium; Cathodic Protection in the m.s. *Regent Springbok;* The Role of Oxygen in Iron-Enamel Adherence.

World Crops—Rice—An Economic and Agronomic Summary; Factors Affecting the World's Food Supplies; Changes in the Structure of West German Agriculture; Precision Surface Drainage for Sugar-Cane Land; New Methods for Testing Viability of Seeds; Soviet Agriculture—Official Urge for Increased Production; Report on the French Agricultural Industry.

Muck Shifter—Developments in Belt Conveyors for Earth Moving; Railway Construction in Uganda; Open-Pit Mining of Low-Grade Ore.

Food Manufacture—Pressure-Packed Foods; Fermented Drinks and Nutrition; Better Grapefruit Products; Fish Dehydration; East Africa's First Margarine Plant; Report on International Fruit Juice Conference.

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